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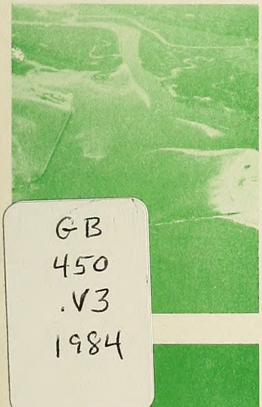

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ECOLOGICAL EFFECTS OF RUBBLE WEIR JETTY CONSTRUCTION AT MURRELLS INLET, SOUTH CAROLINA

VOLUME I: COLONIZATION AND COMMUNITY DEVELOPMENT ON NEW JETTIES

by

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Quarrystone jetties constructed at Murrells Inlet, South Carolina, were studied over a 4-year period to evaluate community development patterns of biota colonizing the rocks. Sessile macroinvertebrates and algae were quantitatively assessed using line-transect and photographed-quadrat censusing techniques. Motile epifauna were also quantitatively sampled using a suction device, and fishes were qualitatively assessed using gill nets, hook and line, traps, seine net, and through visual observations while scuba diving.

(Continued)

20. ABSTRACT (Concluded).

The results documented that both jetties were rapidly colonized by sessile and motile biota. Within 1 year after construction, faunal and floral coverage of the rocks was equivalent to subsequent sampling periods, as were estimates of species diversity and abundance. Distinct vertical zonation of sessile biota was also observed within 1 year, with distribution patterns generally remaining similar throughout the study period. Vertical gradients in the distribution of motile fauna were less apparent, although some differences were noted intertidally versus subtidally. Community composition, on the other hand, changed both seasonally and yearly. Community structure appeared to change less over time in intertidal areas than in subtidal areas, where marked changes in dominant sessile taxa were observed between sampling periods. No stable or "climax" jetty community was apparent subtidally after 3 to 4 years, and other studies suggest that such a community is not likely to occur. Fish found around the jetties were abundant and included several recreationally important species. Stomach content analysis indicated that the jetty biota was an important food resource for several fishes. In addition, at least one species, black sea bass, was using the rocks as a nursery area.

PREFACE

This report was sponsored by the Office, Chief of Engineers (OCE), U. S. Army, as a part of the Environmental Impact Research Program (EIRP) Work Unit 31532 entitled Ecological Effects of Rubble Structures, which was assigned to the U. S. Army Coastal Engineering Research Center (CERC). The Center, originally located at Fort Belvoir, Va., moved to the U. S. Army Engineer Waterways Experiment Station (WES), Vicksburg, Miss., on 1 July 1983. The Technical Monitors for the study were Dr. John Bushman and Mr. Earl Eiker of OCE and Mr. Dave Mathis, Water Resources Support Center.

The study and preparation of a draft final report were accomplished during the time period September 1977 to May 1983.

The report was prepared by Dr. Robert F. Van Dolah, Mr. David M. Knott, and Dr. Dale R. Calder through the Marine Resources Research Institute of the South Carolina Wildlife and Marine Resources Department. Dr. Calder is currently at the Royal Ontario Museum.

The authors are very grateful to Mr. Arthur K. Hurme and Mr. E. J. Pullen of the CERC for their role in initiating this investigation, and for their support and encouragement throughout the study. We wish to thank Magdalene Maclin, Beth Roland and George Steele for their considerable efforts on this project, both in the field and laboratory. Other individuals who frequently assisted us in the field included Mary Jo Clise, Stan Hales, Priscilla Hinde, Terry Hodges and Caroline O'Rourke. Particular thanks are due to Dr. Reid Wiseman, who identified all of the algae found on the jetties, and to Dr. George Sedberry, who identified and analyzed the contents of fish stomachs. Finally, we wish to thank Nancy Beaumont who typed the various drafts of this report, and Karen Swanson who drafted all the figures.

Mr. Hurme was the CERC Technical Advisor for the contract under the general supervision of Mr. Pullen, Chief, CERC Coastal Ecology Branch, and Mr. R. P. Savage, Chief, CERC Research Division. Dr. Roger T. Saucier, WES, was the Program Manager of EIRP.

Technical Director of CERC at Fort Belvoir during the study and preparation of the draft final report was Dr. Robert W. Whalin. Commander and Director of WES during preparation of the final report was COL Tilford C. Creel, CE; Technical Director was Mr. F. R. Brown.

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I. INTRODUCTION

The South Carolina coast consists of numerous barrier islands separated by estuaries and high salinity inlets. Beach and nearshore sediments in this region are largely composed of sand and shell fragments with very little rocky substrata present. Thus, well-developed intertidal communities of epibenthic organisms are sparse and restricted to the few jetties, groins, and other artificial breakwaters in the area. Subtidal epibenthic communities occur more frequently in association with natural hard bottom areas, artificial reefs, wrecks and jetty rocks, but these habitats are still relatively rare in South Carolina and other southeastern states. As a result, there have been few investigations of the benthos on hard substrates in this region, and most of those studies have concentrated on hard bottom areas of the continental shelf (for reviews, see Continental Shelf Associates, 1979; Wenner et al., 1983), or on fouling plate assemblages (Woods Hole Oceanographic Institution, 1952; Sutherland, 1974; Sutherland and Karlson, 1977; Karlson, 1978).

Only two studies have been published on the fauna of jetties in South Carolina. Stephenson and Stephenson (1952, 1972) discussed the intertidal biota on rock jetties and breakwaters at Charleston based on a 1947 visit, and McCloskey (1970) characterized the community structure of fauna associated with the coral *Oculina* on the Charleston jetties. The Murrells Inlet Navigation Project, authorized by Congress in 1971, provided an opportunity to gain a better understanding of hard and soft bottom marine communities in South Carolina waters and to evaluate changes in those communities following jetty construction. A preliminary assessment of the benthic community at Murrells Inlet was conducted in 1975 (Calder et al., 1976). This report presents detailed data obtained from more recent biological investigations conducted at Murrells Inlet before, during, and after jetty placement. Volume I describes the colonization and community development of algae, macroinvertebrates, and fish on the jetties. Changes in the nearby intertidal and subtidal infaunal communities are described in Volume II.

Specific objectives for the study described in this volume were to:

1. Identify annual changes in the community composition, distribution, and abundance of the algae and macroinvertebrates colonizing the north jetty during the first four years.

2. Document early recruitment and seasonal changes in community composition, distribution, and abundance of algae and macroinvertebrates on the south jetty during the first year, and describe subsequent annual variation.

3. Delineate patterns of vertical biological zonation on both jetties from the jetty base to the supratidal zone.

4. Define differences in community structure related to wave exposure.

5. Identify fish species utilizing the jetty as a habitat, and characterize the food habits of selected species through analysis of their stomach contents.

II. DESCRIPTION OF THE STUDY AREA

Murrells Inlet, located on the northeastern coast of South Carolina (Fig. 1), is a comparatively small coastal system characterized by ocean beaches, sand and mud flats, intertidal shellfish beds, and expanses of saltmarshes intersected by shallow tidal creeks. Salinities are generally high and stable because of the lack of either a river system flowing into the inlet or contact with the Atlantic Intracoastal Waterway. Water temperatures are more variable, being dependent on the season, and tides are semidiurnal with a mean tidal range of 1.4 m (National Ocean Survey, 1981).

At its entrance, Murrells Inlet is flanked by Garden City Beach to the northeast and Huntington Beach to the southwest (Fig. 1). The sediments of these beaches and adjacent nearshore areas consist primarily of medium to fine quartz sand with varying amounts of sand-size shell fragments (see Volume II). Although exposed to the open ocean, wave energy is moderate on these beaches because waters are shallow for a considerable distance offshore.

Because Murrells Inlet is intensively utilized as the home port for a growing number of commercial and recreational fishing boats, there was a need to stabilize the entrance channel to the inlet. In October 1977, construction began on two quarrystone jetties located on the north and south sides of the inlet entrance (Fig. 1). The north jetty, which extends 1020 m into the ocean, was completed by February 1979. The landward portion of this jetty includes a 411-m weir section (Fig. 1) designed to allow sand to bypass the jetty and settle into a dredged deposition basin, instead of moving around the jetty and creating shoals at the entrance channel. Construction on the south jetty, which extends 1011 m seaward, began in February 1979 and was completed by May 1980. This jetty has no weir section and is topped with an asphalt walkway. Approximate heights of the north and south jetties range from 2.5 to 3.5 m above mean low water (MLW) except at the weir, where the height is approximately 0.7 m above MLW. Crest width on both jetties is approximately 6 m, and the sides slope at an angle of 45° (1V:1H). Granite armor stones of the jetties vary between 5.4×10^3 kg and 9.1×10^3 kg, and individual stone faces vary from horizontal to vertical. Much smaller stones of various sizes are present at the base of each jetty to prevent erosion around the armor stones.

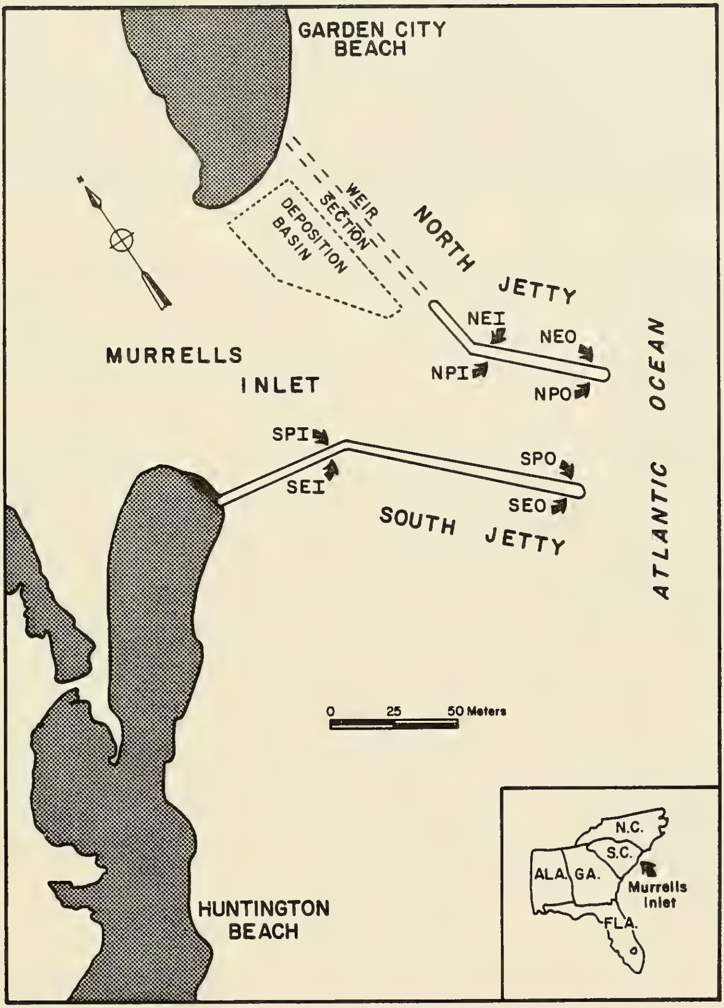

Figure 1. Map showing Murrells Inlet jetties and station locations.

III. MATERIALS AND METHODS

1. Station Characteristics and Sampling Levels

Sampling was conducted at four stations on each jetty, two located on opposite sides of the jetty near the outer (offshore) end and two located opposite one another near the inner (inshore) bend of the jetty (Fig. 1). This arrangement provided sampling sites on rocks which had been laid down at different seasons of the year, and also allowed comparisons between wave-exposed and sheltered sides of jetty rocks laid down at the same time. Table 1 provides a listing of the station designations and the date of rock placement at those locations.

Six intertidal levels were sampled at each station to provide information on the vertical zonation of biota on the rocks. These levels were located at mean low water (MLW) and 0.5 m, 1.0 m, 1.5 m, 2.0 m, and 2.5 m above MLW. With a mean tidal range of 1.4 m at Murrells Inlet (National Ocean Survey, 1981), these levels encompassed the entire intertidal zone and extended into the supratidal region near the crest of the jetty.

Biotic zonation was less pronounced in the subtidal region, and stations were located at 1-m intervals below MLW. Shallow waters in the vicinity of the north jetty limited sampling to levels at depths of -1 m (below MLW) on the inner transects and at -1 m and -2 m on the outer transects. Water was even shallower around the south jetty. No subtidal levels were sampled on the exposed side, and only the -1-m level could be sampled on the sheltered side of that jetty. All subtidal levels of both jetties were located at least 0.5 m above the bottom to avoid scouring effects due to wave-entrained sand. By the summer of 1981, additional shoaling had occurred around the south jetty, resulting in burial of the MLW and -1-m levels on the channel side (SPI) and the 0.5-m and MLW levels on the exposed side (SEI). Shoaling continued and by the summer of 1982, the 0.5-m sampling level at SPI was also buried.

Benchmarks at known elevations above MLW were marked with paint at the top of each transect. Intertidal levels were located using metered plumb lines oriented to the benchmarks. Subtidal levels were sampled using scuba and were located using a float and metered line. The float line was adjusted to the appropriate length based on tidal height of the water compared to the benchmark height.

2. Sampling Dates

The first samples were collected at north jetty stations during July 1979, one year after construction at the inner stations and 8 months after construction at the outer stations. Sampling was then repeated during the summer (July or August) at yearly intervals through 1982.

The first south jetty samples were collected in May 1980, seven months after rock emplacement at the inner stations and three months after rock emplacement at the outer stations. Sampling was repeated at

Table 1. Station designation and date of establishment during jetty construction. (See Figure 1 for additional information.)

STATION	LOCATION	DATE OF ROCK PLACEMENT
	NORTH JETTY	
NEI	exposed side, inner segment of jetty	July 1978
NPI	protected side, inner segment of jetty	July 1978
NEO	exposed side, outer segment of jetty	November 1978
NPO	protected side, outer segment of jetty	November 1978
	SOUTH JETTY	
SEI	exposed side, inner segment of jetty	October 1979
SPI	protected side, inner segment of jetty	October 1979
SEO	exposed side, outer segment of jetty	February 1980
SPO	protected side, outer segment of jetty	February 1980

quarterly intervals (August, November, February) during the first year after construction, and then at yearly intervals (July or August) through 1982.

3. Biological Sampling Methods

Characterization of epibenthic communities was accomplished using three systematic sampling techniques: (1) line-transect census, (2) photographed-quadrat census, and (3) suction sampling of motile species. Data collected by the three sampling methods provided information on species composition, relative percent cover or abundance, and distribution. In addition, general collections and observations of species were made during all sampling periods.

a. Line Transects

Percent cover of the sessile biota was assessed at each level using a line-transect procedure modified from Loya and Slobodkin (1971), Porter (1972 a,b), and Loya (1972, 1978). For this assessment a clear plastic strip, marked at its edge with 15 points at 2.5-cm intervals, was placed against rock surfaces. All organisms occurring directly under each point were identified and recorded. Because different rock faces often displayed different densities or assemblages of organisms, assessments were made on each of the seaward, landward, outer, inner, and top surfaces of jetty quarrystone. The transect strip was always positioned horizontally on vertical surfaces, and data from the five rock faces were summed to provide an overall estimate of percent cover based on the 75 points at each level. An effort was made to place the plastic strip on the rock faces without reference to the attached biota to avoid sampling bias. If more than one species was present under a point, all were recorded and percent cover estimates for each species at a given level were based on the percentage of points it occupied. Because this procedure commonly resulted in estimates of total biota cover greater than 100%, total estimated biota cover was determined by substracting the estimated percent of unoccupied space from 100. Poor water visibility and waves precluded *in situ* assessment by line transect at the subtidal south jetty levels (only). Instead, rocks were removed from the appropriate depth at those stations and brought to the surface for examination. At all stations, organisms which could not be identified in the field were preserved and returned to the laboratory for identification. Samples of blue-green algae were also collected for laboratory identification, but species in this taxonomic group could not be identified in the field and all were identified only as Cyanophyta.

b. Photographed Quadrats

A photographic census was also conducted to obtain additional quantitative estimates of the jetty epibiota, and to provide a more permanent record of biota at each level. Color photographs were obtained of the same rock faces (i.e., seaward, landward, outer, inner, top) at all station levels using a Nikonos III camera with flash attachment.

The camera was equipped with a 35-mm f2.5 Nikkor lens combined with a 35-mm closeup lens outfit and a rectangular quadrat frame (13 x 18.5 cm). As noted for the line-transect census, all faces and levels were located without reference to the attached biota.

Photographs were analyzed in the laboratory using a slide projector and a screen with 50 computer-generated random points. One of 10 different screens was selected by random number for analysis of slides from each level. Actual rock surface area examined in each slide was 100 cm^2 for the north jetty stations and 150 cm^2 for the south jetty stations. Organisms occurring under the 50 points in each photograph were identified, and percent cover estimates for each species, based on the proportion of points occupied, were calculated for each level (i.e., 250 points/level). Photographic analysis differed slightly from line-transect analysis. Blue-green algae were not assessed in photographs since they could not always be detected, even when present. Furthermore, when there was uncertainty about whether biota existed under a point in the photographs (due to shadows, poor picture quality, etc.), that point was discarded and percent cover estimates were based on the number of analyzable points only.

c. Suction Samples

Motile epifaunal invertebrates were sampled using a modified underwater slurp gun. The levels sampled were +1 m, MLW, -1 m, and -2 m at all stations, except at the inner stations on each jetty, where shallow depths precluded collection at the -2-m level. Three replicate samples were obtained at all levels by placing the opening of the slurp gun (4-cm diameter) flush against a rock face and vigorously pulling the suction rod. Each replicate consisted of five suctions pooled from different rock faces picked haphazardly. The gun was modified so that suction was obtained by venturi action; incoming water through holes drilled in the barrel was filtered through a 1-mm mesh screen. Contents of the slurp gun were emptied into a gallon jug after each suction. To prevent loss of organisms, the mouth of the jug was covered by a 1-mm mesh screen having an opening just large enough to permit insertion of the slurp gun barrel, and the jug was capped except when collections were being added. After the five collections comprising each replicate had been placed in the jug, the container contents were sieved through a 1-mm mesh screen and preserved in a 10% formalin seawater solution. Due to some water leakage around the mouth of the gun and rock face during the suction stroke, the exact surface area sampled per replicate was not defined but approximated 65 cm^2.

d. Fish Observations and Collections

Qualitative observations on ichthyofauna were made during investigations of benthic flora and fauna on the jetty. Fish species observed near the jetties by scuba divers were recorded, baited blackfish traps were set at various locations on the jetty, and a beach seine was pulled along the western side of the weir. In addition, fish species were recorded from gill net collections made in conjunction with a related investigation (Hales and Calder, 1979). Stomachs were removed from the demersal species and preserved for laboratory analysis. In the laboratory, the stomachs were washed in tap water and transferred to 50% isopropanol, and contents of individual stomachs were sorted by taxa and counted. Colonial forms and fragments of animals were counted as one organism unless abundance could be estimated by counting pairs of eyes (crustaceans), otoliths (fishes), or other parts. Any food items (i.e., fish remains) that might have been bait in blackfish traps were not included in the analysis. Volume displacement of food items was measured using a graduated cylinder, or estimated by using a 0.1-cm^2 grid (Windell, 1971).

4. Hydrographic Sampling

During every sampling period, surface and bottom water samples were collected at all stations except SEI, which could not be reached by boat. Samples were obtained using a Van Dorn bottle and the parameters measured were temperature, salinity, dissolved oxygen, and water clarity. Water temperature was measured from stem thermometers mounted inside the Van Dorn bottles. Salinity was measured using a Beckman Model RS7B induction salinometer, or a YSI Model 33 S-C-T meter. Dissolved oxygen was measured using a YSI Model 51-B Dissolved Oxygen Meter, or by the modified Winkler titration method (Strickland and Parsons, 1972). Water clarity was measured using a Secchi disk.

5. Data Analysis

Community structure was evaluated through comparisons of species cover or abundance, diversity indices, and cluster analysis. Where appropriate, abundance estimates obtained from replicate sampling were statistically compared using the non-parametric Mann-Whitney U test. Only the motile macroinvertebrates were counted since most of the sessile fauna and flora observed on the jetties were colonial.

Diversity indices used in the analysis of motile macroinvertebrates included Shannon's index (H') and measurements of species richness (SR) and evenness (J') as described by Margalef (1958) and Pielou (1975). The expressions for these indices are as follows:

$$H' = -\sum_{i=1}^{s} P_i \log_2 P_i$$

where s is the number of species and P_i is the proportion of the i^{th} species in a collection,

$$SR = \frac{(s - 1)}{\log_e n}$$

where s is the number of species and n is the number of individuals in a collection, and

$$J' = \frac{H'}{\log_2 s}$$

These measures were computed on data from pooled replicates of suction samples at each level since pooling the replicates provided a larger sample size and a more representative estimate of community diversity at a site. Diversity of the sessile biota which generally could not be counted was limited to comparisons of the number of species (s) observed in photographs and along line transects.

Cluster analysis was used to determine patterns of similarity among stations. The quantitative measure used in all analyses was the Bray-Curtis coefficient (Boesch, 1977):

$$S_{jk} = 1 - \frac{\sum_i \left| x_{ji} - x_{ki} \right|}{\sum_i (x_{ji} + x_{ki})}$$

where x_{ji} and x_{ki} are the number of individuals of the i^{th} species in two collections under comparison. A normal analysis was completed on the site groups using modified data sets and a flexible sorting strategy with a standard β value of -0.25. Data sets represented pooled collections from the different levels at a site (station), separated by seasons. Additional modifications to the data sets included log transformation and deletion of taxa which occurred in only one collection, as well as deletion of those taxa of uncertain identity. These deletions were made to simplify the data sets and because "rare" species usually do not have definable distribution patterns, and can confuse interpretation of cluster analysis.

Quantification techniques for food habits of fish are biased, depending on the method (Hynes, 1950; Pinkas et al., 1971; Windell, 1971). Therefore, the relative contribution of different food items to the total diet was determined using three methods: percent frequency occurrence (F), percent numerical abundance (N), and percent volume displacement (V). From these, an index of relative importance (IRI) (Pinkas et al., 1971) was calculated for each prey species and higher taxon as follows:

$$IRI = (N + V)\ F$$

where N, V and F are the numerical, volumetric, and frequency percentages as defined above. This index has proven useful in evaluating the relative importance of different food items found in fish stomachs (Pinkas et al., 1971; McEachran et al., 1976; Sedberry, 1983) and was used in the present study to describe the food habits of each species.

IV. RESULTS AND DISCUSSION

1. Hydrographic Conditions

Water sample analysis for temperature, salinity and dissolved oxygen (Tables 2 and 3) reflected expected hydrographic patterns for this area. Temperature differences between surface and bottom waters were always similar with a normal difference of less than 0.3°C. Lowest temperatures (5.8° - 6.0°C) were observed during the winter and highest temperatures (26.5° - 30.3°C) occurred during summer. Salinity measurements were always high (34.5 - 36.1 °/oo) during the four-year study period since Murrells Inlet receives no significant fresh water input. No salinity data are presented for 1982 due to a faulty meter, but refractometer estimates indicated that salinities were in the same range that year. Dissolved oxygen values were generally high and near saturation values since the shallow waters in this area are well mixed by wave action. Finally, no consistent differences were noted between stations on the north versus south jetty.

Water clarity varied considerably during the study, being mostly dependent on tidal stage and wave action. Clarity increased during flood tides and was often greatest on the exposed side of the north jetty. The turbid waters from the inlet decreased water clarity at channel (protected) stations on both jetties, especially during ebb tides. The very shallow waters on the exposed side of the south jetty were also generally more turbid than on the deeper exposed side of the north jetty.

2. Jetty Community Development

Data obtained from north and south jetty sampling indicate that a diverse assemblage of biota colonized the rocks during the first four years after construction. At least 25 species of algae, 195 species of macroinvertebrates and 34 species of fish were observed or collected on the jetties, with distinct temporal changes noted each year in the community composition. Vertical gradients in the distribution of fauna and flora on the rocks were also evident, particularly in the intertidal zone. The following sections provide details on the colonization, community development, and distribution patterns observed on both jetties.

a. Sessile Biota.

Percent cover estimates for the sessile macroinvertebrates and algal species are listed in Appendices A and B for the four north jetty study sites, and Appendices C and D for the four south jetty sites. Appendix E provides estimates of total biota cover on the rocks using the two census techniques. The line-transect census (Appendices A and C) generally provided more detailed information on community composition at the different levels because taxonomic identifications were often more refined than possible in the analysis of photographed quadrats (Appendices B and D). However, the latter technique did provide useful supplemental information, particularly for the larger dominant biota which could be easily identified.

Table 2. Temperature, salinity, dissolved oxygen and water clarity measurements collected during sampling periods at north jetty stations.

	NEI		NEO		NPI		NPO	
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
				TEMPERATURE (^{o}C)				
Summer, 1979	28.4	28.3	28.4	28.4	28.4	28.3	28.3	28.3
Summer, 1980	28.4	28.2	28.3	28.2	28.9	28.8	28.8	28.8
Summer, 1981	26.7	26.7	26.5	26.6	26.6	26.7	26.6	26.6
Summer, 1982	28.2	28.0	28.2	28.2	28.2	28.2	28.2	28.2
				SALINITY (^{o}/oo)				
Summer, 1979	35.6	35.5	35.5	35.5	35.5	35.5	35.5	35.5
Summer, 1980	35.5	35.5	35.5	35.5	35.4	35.4	35.4	34.5
Summer, 1981	35.7	35.7	35.6	35.6	35.8	35.8	35.8	35.8
Summer, 1982				NO DATA				
				DISSOLVED OXYGEN (mg/ℓ)				
Summer, 1979	6.9	7.0	7.0	6.9	6.4	6.7	6.9	6.8
Summer, 1980	6.7	6.2	6.1	6.0	6.7	6.6	7.0	6.8
Summer, 1981	6.8	6.4	6.9	6.7	6.5	6.6	6.7	6.8
Summer, 1982	5.0	5.0	5.1	4.8	4.8	4.6	4.7	4.8
				WATER CLARITY (m)				
Summer, 1979	1.9		2.3		1.5		1.8	
Summer, 1980	0.7		0.8		1.0		1.0	
Summer, 1981	2.5		2.4		1.6		1.6	
Summer, 1982				NO DATA				

Table 3. Temperature, salinity, dissolved oxygen and water clarity measurements collected during sampling periods at south jetty stations.

	SEI		SEO		SPI		SPO	
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
				TEMPERATURE (^oC)				
Spring, 1980	NO DATA		24.7	24.1	24.7	24.0	24.2	24.1
Summer, 1980			29.3	29.3	30.2	30.1	30.2	30.3
Fall, 1980			15.7	15.7	15.0	14.9	15.2	15.2
Winter, 1981			6.0	6.0	5.9	5.9	5.8	5.8
Summer, 1981			26.9	27.0	27.4	27.3	26.9	26.9
Summer, 1982			28.2	28.2	28.5	29.0	28.5	28.2
				SALINITY ($^o/oo$)				
Spring, 1980	NO DATA		34.5	34.6	34.6	34.5	34.5	34.5
Summer, 1980			35.1	35.1	35.2	35.2	35.2	35.2
Fall, 1980			35.1	35.1	35.4	35.4	35.5	35.5
Winter, 1981			36.1	36.1	36.1	36.1	36.1	36.1
Summer, 1981			35.8	35.8	35.8	35.8	35.7	35.7
Summer, 1982				NO DATA				
				DISSOLVED OXYGEN (mg/ℓ)				
Spring, 1980	NO DATA		7.9	7.9	7.5	7.6	8.0	7.9
Summer, 1980			6.9	7.0	7.1	7.5	6.9	6.8
Fall, 1980			7.8	7.9	8.2	8.3	8.2	8.3
Winter, 1981			10.2	10.4	10.1	10.3	10.4	10.1
Summer, 1981			6.8	6.4	6.6	6.4	6.9	6.9
Summer, 1982			5.2	5.2	5.2	5.2	5.4	5.4
				WATER CLARITY (m)				
Spring, 1980	NO DATA		1.4		1.1		1.5	
Summer, 1980			0.9		1.0		1.5	
Fall, 1980			1.0		1.1		1.0	
Winter, 1981			1.1		1.3		1.5	
Summer, 1981			1.6		1.0		1.7	
Summer, 1982				NO DATA				

(1). Total Biota Cover and Number of Taxa

Estimates of total biota cover at the different levels of north jetty stations indicated no consistent or marked differences between inner and outer sites on the same side of the jetty (Appendix E.1). Biota cover on the rocks one year after construction was generally as great as in subsequent years (Fig. 2). This was primarily due to early settling of blue-green algae and the barnacle *Chthamalus fragilis* intertidally, and settling of the mussel *Brachidontes exustus* at lower intertidal and subtidal levels.

Biota cover at inner and outer south jetty stations did differ considerably in the spring of 1980, with outer sites having less cover than inner sites at all levels where biota was present (Appendix E.2). Rocks at the outer stations had only been submerged for 2-3 months as compared to 7 months of submersion at the inner stations. By the summer of 1980, biota cover at all levels on the rocks had increased to percentages as great or greater than those found in subsequent sampling periods (Fig. 3).

In the upper intertidal zone (1.5 m - 2.0 m above MLW), biota cover was often greater on the wave-exposed side as compared with the sheltered side of the jetties (Figs. 2 and 3). This vertical extension in the amount of biota cover on the exposed side is a common pattern which has been observed in several other rocky intertidal systems (Lewis, 1972). Biota cover on the rocks of both jetties generally increased at the lower levels, and differences between sides were not as great. Because cover on the exposed side was rarely less than on the wave-protected side (Figs. 2 and 3), it is unlikely that wave shock represents a major source of mortality as noted in other rocky intertidal systems (Dayton, 1971; Menge, 1978). However, wave energy in those systems is often considerably greater than the moderate wave energy observed at Murrells Inlet.

Comparisons of biota cover estimates obtained by line-transect versus photographic census (Figs. 2 and 3) showed strong similarities except at the highest intertidal levels. Blue-green algae were dominant in the upper intertidal zone, and these species of algae were not assessed in the photographs.

Since many of the sessile organisms are colonial, species diversity indices were not calculated on this component of the jetty communities. However, an examination of the number of taxa found on the rocks indicates that there were fewer species in the intertidal zone than in the subtidal zone on both jetties (Figs. 4 and 5, Appendices A-D). The more rigorous physical environment associated with the intertidal habitat obviously limits the number of species which can colonize this area as compared with the less stressful subtidal environment.

In both the intertidal and subtidal zones, the number of taxa present on the jetty within one year after construction was nearly equivalent to or greater than the number found in later years (Figs. 4 and 5). Additionally, there were no major or consistent differences in the number of taxa found on the wave-exposed versus sheltered sides of the jetties.

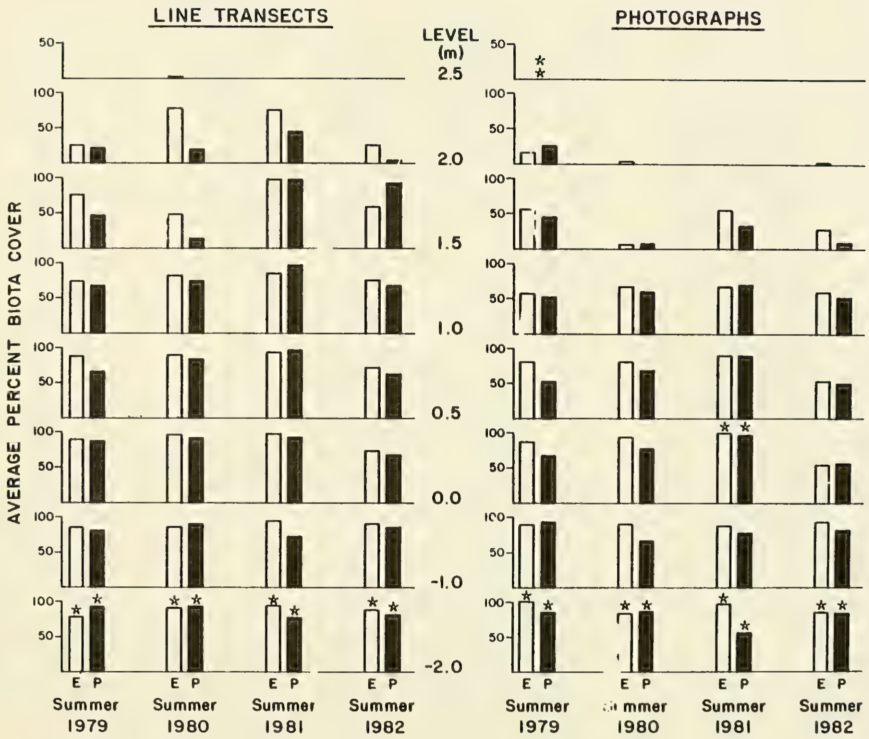

Figure 2. Line-transect and photograph estimates of sessile biota cover at different levels of the north jetty. Histograms represent averages from the two stations on the exposed (E) side and the protected (P) side. * indicates that only one station is represented, ** indicates no data.

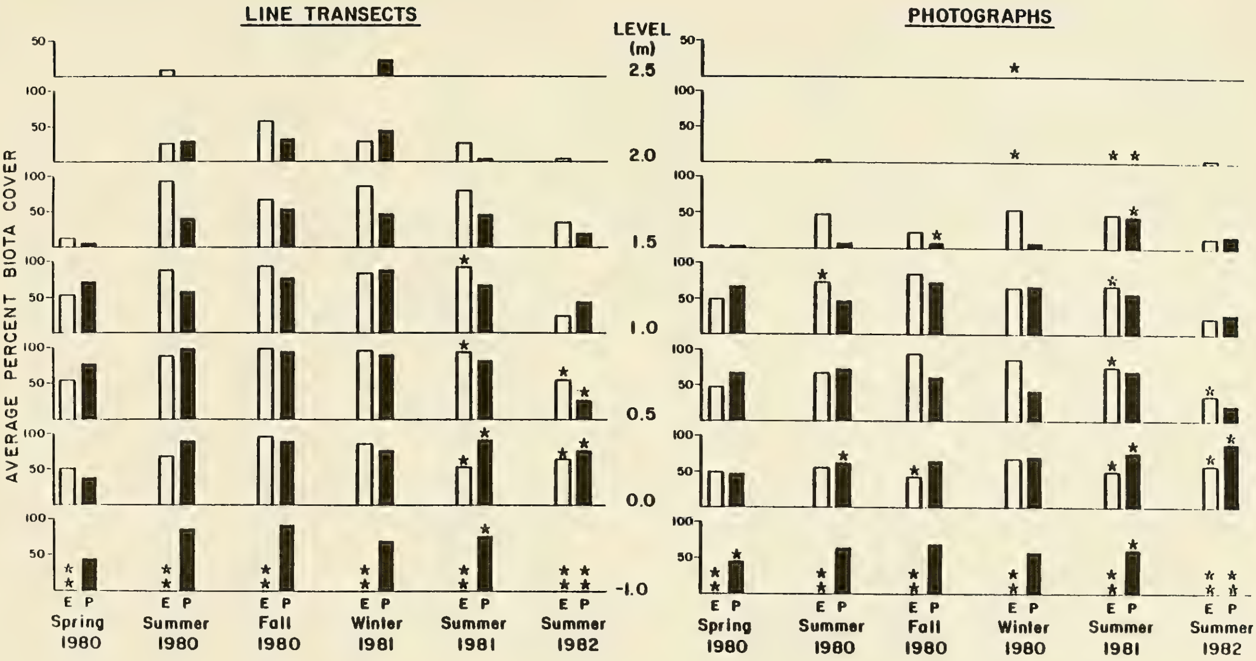

Figure 3. Line-transect and photograph estimates of sessile biota cover at different levels of the south jetty. Histograms represent averages from the two stations on the exposed (E) side and the protected (P) side. * indicates that only one station is represented, ** indicates no data.

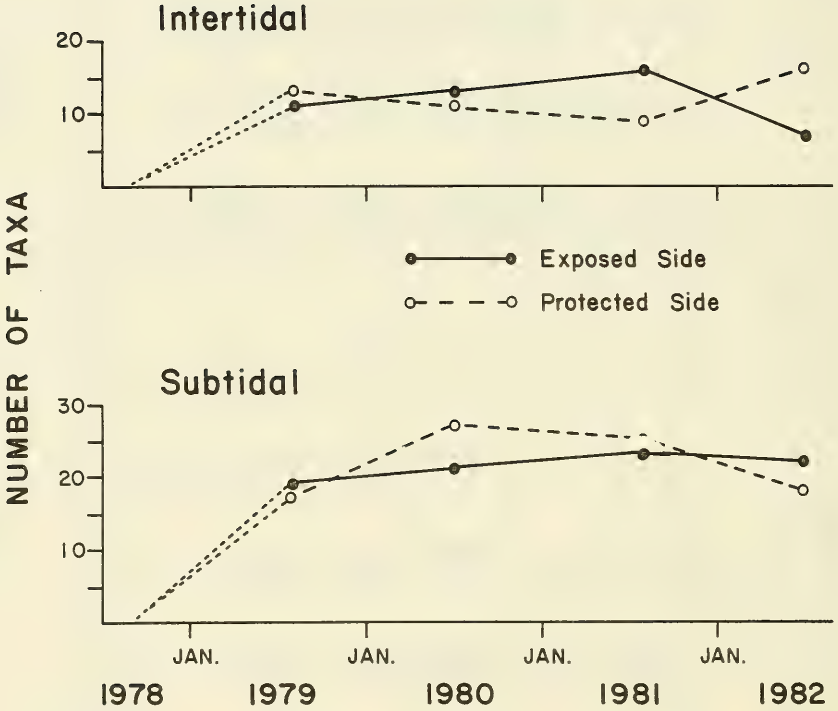

Figure 4. Total number of sessile taxa observed at intertidal and subtidal levels of north jetty stations during line-transect census.

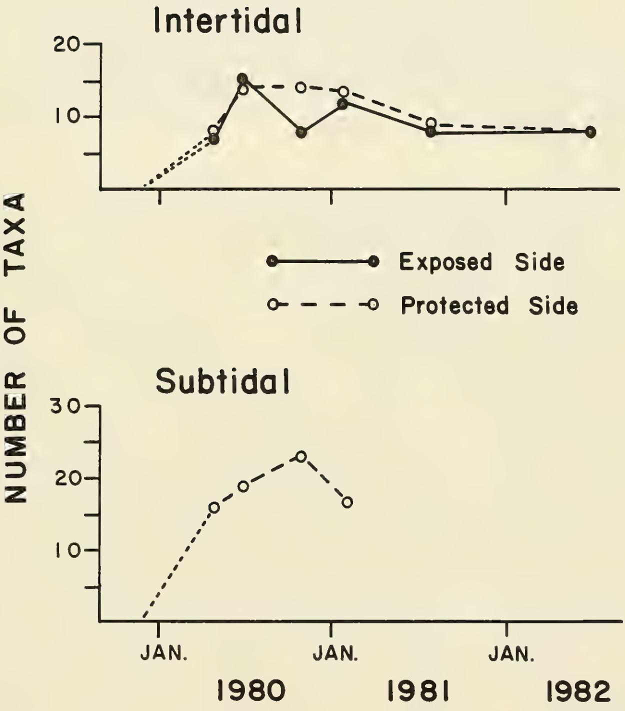

Figure 5. Total number of sessile taxa observed at intertidal and subtidal levels of south jetty stations during line-transect census.

If wave stress at Murrells Inlet had been greater, differences in the diversity of species might have been more apparent, as noted in other rocky intertidal systems (Menge and Sutherland, 1976).

(2). Community Composition

(a). North Jetty

Although estimates of total biota cover and the number of taxa on the north jetty rocks did not change markedly over the four-year study period, community composition of the sessile biota did vary considerably between years (Tables 4 and 5; Figs. 6 and 7). Major differences were also observed in the intertidal versus subtidal community composition and, to a lesser extent, between the wave-exposed and protected sides.

One year after jetty construction, the dominant intertidal species at all stations were the barnacle *Chthamalus fragilis* and the mussel *Brachidontes exustus*. These two species accounted for approximately 63% of all biota cover in this zone. The oyster *Crassostrea virginica* and the barnacle *Balanus eburneus* were the only other fauna among the ten dominant organisms found intertidally. Blue-green algae (Cyanophyta) was the primary intertidal algal form during the first year. The dominant species of blue-greens were *Anacystis aeruginosa*, *Microcoleus lyngbyaceous*, and *Calothrix crustacea*. These three species were noted during all later sampling periods, as well. Other algal species found on the rocks included the green algae *Cladophora* sp. (primarily *C. laetevirens*) and *Ulva* sp., and the red algae *Hypnea musciformis*, *Lomentaria baileyana* and *Herposiphonia tenella*. Although barnacle and mussel cover was generally similar on both sides of the jetty in 1979, blue-green and green algae were the predominant algal forms on the exposed side, whereas red algae were predominant on the protected side.

Chthamalus fragilis, *Brachidontes exustus*, *Ulva* sp. and Cyanophyta continued to dominate the intertidal biota cover during the next three years (Tables 4 and 5). In 1980, rock coverage by the different taxa was similar to that observed in 1979 (Figs. 6 and 7), but by 1981, algal cover had increased. The line-transect census indicated that blue-green algae was more prevalent this year than in any other year. Larger macrophyte coverage had also increased to a lesser extent, with green algae (*Ulva* sp., *Enteromorpha* sp., and *Cladophora* sp.) generally being more common on both sides of the jetty than red algae (*Gracilaria foliifera*, *Porphyra* sp., *Hypnea musciformis* and *Polysiphonia* sp.). By 1982, algal and mussel cover had decreased considerably. Barnacles (*C. fragilis*) represented the dominant biota on the rocks, although blue-green algae was also common.

The decline in algal and mussel cover during the last year of study is not readily explained. Some of this decline may be attributed to mortality. Additionally, both taxonomic groups were concentrated in only the lowest portion of the intertidal zone during all four years, and the MLW sampling level represented the upper limit for many of the

Table 4. Listing of the top ten intertidal and subtidal sessile taxa observed on the north jetty rocks by line-transect census.

RANK	SUMMER 1979	SUMMER 1980	SUMMER 1981	SUMMER 1982
		INTERTIDAL		
1	*Brachidontes exustus*	*Chthamalus fragilis*	Cyanophyta	*Chthamalus fragilis*
2	*Chthamalus fragilis*	*Brachidontes exustus*	*Brachidontes exustus*	Cyanophyta
3	Cyanophyta	Cyanophyta	*Chthamalus fragilis*	*Ulva* sp.
4	*Hypnea musciformis*	*Ulva* sp.	*Ulva* sp.	*Brachidontes exustus*
5	*Crassostrea virginica*	*Polysiphonia* sp.	*Enteromorpha* sp.	*Crassostrea virginica*
6	*Balanus eburneus*	*Crassostrea virginica*	*Gracilaria foliifera*	*Hypnea musciformis*
7	*Lomentaria baileyana*	*Enteromorpha* sp.	*Crassostrea virginica*	*Balanus eburneus*
8	*Herposiphonia tenella*	*Cladophora* sp.	*Porphyra* sp.	*Bryopsis plumosa*
9	*Cladophora* sp.	*Balanus improvisus*	*Polysiphonia* sp.	*Balanus venustus*
10	*Ulva* sp.	*Hypnea musciformis*	*Rhodymenia pseudopalmata*	*Balanus improvisus*
		SUBTIDAL		
1	*Brachidontes exustus*	*Obelia dichotoma*	*Eudistoma carolinense*	*Gracilaria foliifera*
2	*Obelia dichotoma*	*Rhodymenia pseudopalmata*	*Gracilaria foliifera*	*Rhodymenia pseudopalmata*
3	*Perophora viridis*	*Ulva* sp.	*Rhodymenia pseudopalmata*	*Hypnea musciformis*
4	*Bugula neritina*	*Schizoporella errata*	*Obelia dichotoma*	*Eudistoma carolinense*
5	*Polysiphonia* sp.	*Brachidontes exustus*	*Distaplia bermudensis*	*Obelia geniculata*
6	*Lomentaria baileyana*	*Bugula neritina*	*Brachidontes exustus*	*Bryopsis plumosa*
7	*Aplidium* sp.	*Eudistoma carolinense*	*Polysiphonia* sp.	*Sertularia marginata*
8	*Asterias forbesii*	*Gracilaria foliifera*	*Crisia* sp.	*Distaplia bermudensis*
9	*Dynamena cornicina*	*Lomentaria baileyana*	*Bugula neritina*	*Sertularia distans*
10	*Molgula manhattensis*	*Cladophora* sp.	*Thalamoporella gothica*	*Cladophora* sp.

Table 5. Listing of the top ten intertidal and subtidal sessile taxa observed on the north jetty rocks by photographic census.

RANK	SUMMER 1979	SUMMER 1980	SUMMER 1981	SUMMER 1982
		INTERTIDAL		
1	*Brachidontes exustus*	*Chthamalus fragilis*	*Ulva* sp.	*Chthamalus fragilis*
2	*Chthamalus fragilis*	*Brachidontes exustus*	*Chthamalus fragilis*	*Ulva* sp.
3	*Ulva* sp.	*Ulva* sp.	*Brachidontes exustus*	*Brachidontes exustus*
4	*Crassostrea virginica*	*Crassostrea virginica*	*Enteromorpha* sp.	*Crassostrea virginica*
5	*Enteromorpha* sp.	Balanomorpha	*Crassostrea virginica*	*Hypnea musciformis*
6	*Balanus eburneus*	*Hydroides* sp.	*Gracilaria foliifera*	Balanomorpha
7	*Gracilaria foliifera*		*Cladophora* sp.	*Balanus eburneus*
8	*Porphyra* sp.		*Porphyra* sp.	*Bryopsis plumosa*
9	*Balanus* sp.		*Hypnea musciformis*	*Hydroides* sp.
10	*Halocordyle disticha*		Balanomorpha	*Balanus* sp.
		SUBTIDAL		
1	*Brachidontes exustus*	*Obelia dichotoma*	*Rhodymenia pseudopalmata*	*Rhodymenia pseudopalmata*
2	*Asteria forbesii*	*Anguinella palmata*	*Gracilaria foliifera*	*Gracilaria foliifera*
3	*Halocordyle disticha*	*Schizoporella errata*	*Eudistoma carolinense*	*Hypnea musciformis*
4	*Perophora viridis*	*Gracilaria foliifera*	*Eudistoma hepaticum*	Ascidiacea
5	*Gracilaria foliifera*	*Rhodymenia pseudopalmata*	Ascidiacea A	*Eudistoma carolinense*
6	*Distaplia bermudensis*	Ascidiacea	*Ulva* sp.	*Ulva* sp.
7	*Clavelina picta*	*Ulva* sp.	*Distaplia bermudensis*	*Arbacia punctulata*
8	*Hydroides* sp.	*Bugula neritina*	*Leptogorgia virgulata*	*Obelia* sp.
9	*Schizoporella errata*	*Eudistoma carolinense*	*Obelia geniculata*	*Cladophora* sp.
10	*Leptogorgia virgulata*	*Cladophora* sp.	*Crisia* sp.	*Eudendrium carneum*

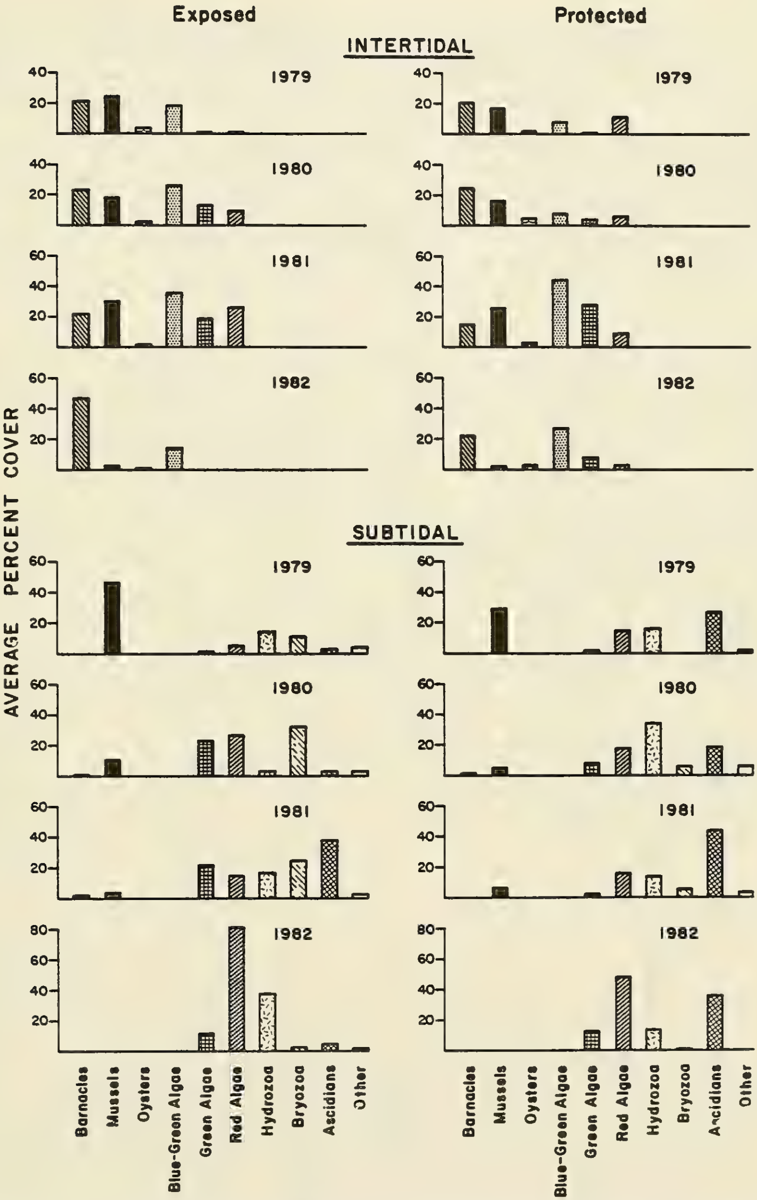

Figure 6. Line-transect estimates of mean percent cover for the different sessile taxa found on the north jetty rocks. Histograms represent means from the 2.0-m to MLW intertidal levels, and the -1- and -2-m subtidal levels.

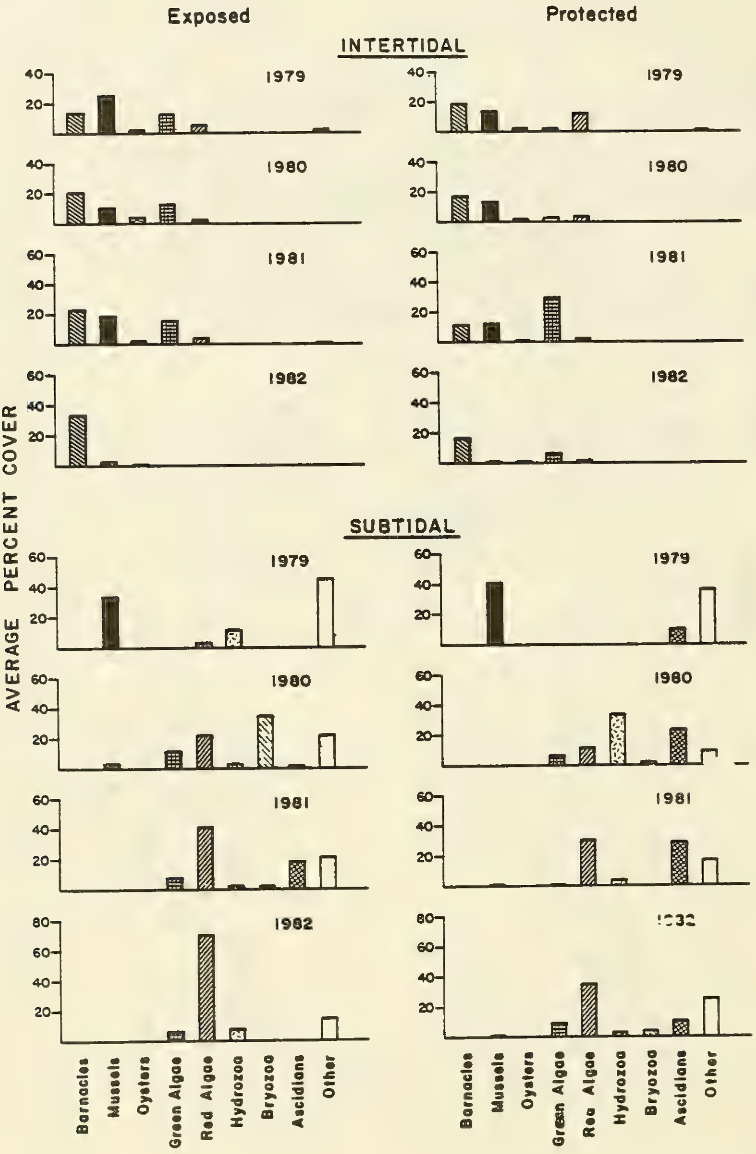

Figure 7. Photographic estimates of mean percent cover for the different sessile taxa found on the north jetty rocks. Histograms represent means from the 2.0-m to MLW intertidal levels, and the -1- and -2-m subtidal levels.

species. During the 1982 assessment, algae and mussels were abundant just below the MLW sampling level. Thus, it is possible that the levels selected in that year were slightly higher (2-5 cm) than the levels selected in previous years, causing lowered estimates of these taxa.

In the subtidal zone, different taxa dominated when compared with the intertidal zone, and major changes occurred yearly in the most abundant biota (Tables 4 and 5, Figs. 6 and 7). One year after construction, the subtidal rocks were primarily covered with the mussel *B. exustus* on the exposed side. Rocks on the wave-sheltered side had fewer *B. exustus* and more ascidians (primarily *Perophora viridis*, *Aplidium* sp. and *Molgula manhattensis*), but mussels were still the dominant taxon.

One year later, mussel density had declined significantly and both sides had heavy algal cover. The decreased mussel density was most likely due to predation by sheepshead (*Archosargus probatocephalus*) and by dense aggregations of the starfish *Asterias forbesii*, which were seen grazing on the mussels during the summer of 1979. Mussel density remained low on the subtidal rocks for the remainder of the study.

Prominent algal species which colonized the rocks during the second year included the red algae *Gracilaria foliifera* and *Rhodymenia pseudopalmata*, and the green alga *Ulva* sp. Algae appeared to be more prevalent on the exposed side, which may be due to greater light penetration in the clearer waters generally observed on that side. Bryozoans were also common on the exposed side in 1980, and they were much more abundant there than on the wave-protected side. Dominant bryozoans included the stalked forms *Anguinella palmata* and *Bugula neritina*, and the encrusting form *Schizoporella errata* (Tables 4 and 5). On the protected side, hydroids and ascidians were more prevalent than bryozoans, which were relatively rare on that side. The most common hydroid was *Obelia dichotoma*. This species grew primarily on the red algae. The dominant ascidian was *Eudistoma carolinense*, which formed large mats of clumped zooids having sand-covered tests. Because of its morphological complexity, this ascidian species provided excellent habitat for a diversity of smaller, more motile invertebrates.

By 1981, the third year after jetty construction, ascidians had become quite common on both sides of the jetty. *Eudistoma carolinense* and *Distaplia bermudensis* were the most abundant ascidians on the exposed side, and *E. carolinense* remained as the dominant species on the wave-sheltered side (Appendices A and B). Algae was also common on both sides, with red algae (*G. foliifera* and *R. pseudopalmata*) being more prevalent than green algae. The hydroid *Obelia dichotoma* was often observed growing on the red algae. Many stalked bryozoans, such as *Crisia* sp., *Anguinella palmata*, and *Bugula neritina* were commonly observed attached to the rocks. The encrusting bryozoan *Schizoporella errata* did not appear to be as common in 1981 as in the preceding year, but another encrusting form, *Thalamoporella gothica*, was noted for the first time on the rocks (Appendix A). This latter species often grew in large erect colonies shaped in the form of lettuce heads. Finally, the octocoral *Leptogorgia virgulata*, was often noted growing on the rocks, especially at the base of the jetties.

During the last year of study, dominance in biota cover had changed once again. Although ascidians were still common, especially on the channel side of the jetty, algae represented the dominant biota cover in 1982 (Tables 4 and 5, Figs. 6 and 7). Red algae was much more prevalent than green algae, with lush stands of *R. pseudopalmata, G. foliifera* and *H. musciformis* covering the hard substrata. *Rhodymenia pseudopalmata* was more abundant on the exposed side, and it was the most prominent alga in the shallower depths (-1 m). Hydroids, such as *Dynamena* spp., *Obelia* spp., and *Sertularia* spp., were common on the algae and rocks of the exposed side. Hydroids were also common on the channel side of the jetty, but to a lesser extent. However, one hydroid (*Halocordyle disticha*) appeared to be more abundant on the channel side than on the exposed side. *Eudistoma carolinense* and *D. bermudensis* were the most common ascidians on the rocks during the summer of 1982.

Cluster analysis of line-transect data on the entire north jetty sessile community (Fig. 8) supports the hypothesis that the overall community structure changed substantially over the four-year period. All stations sampled in the first year grouped together with a relatively high degree of similarity in faunal and floral composition (Group 1). Within that group, the inner stations were more similar to each other than to the outer stations, indicating differences in community composition between those station groups. These differences were probably related to the 6-month difference in time of rock submersion and the difference in the number of levels sampled at the outer stations. With one exception (NPO; SU, 1980), community structure in 1979 was relatively dissimilar to the community structure observed in later years (Groups 2 and 3). Station collections from 1980 and 1981 formed Group 2, demonstrating more similarity among collections from those years than from the first and last years of the study. Within that group, 1981 collections were generally more similar to each other than to 1980 collections. The two 1980 collections at the inner stations remained relatively dissimilar to the other collections in that year and in 1981. Community structure at stations sampled in 1982 was very low in similarity to the same stations sampled in previous years (Group 3). Additionally, there was a distinct separation of protected and exposed stations based on faunal similarity. These major shifts in overall community composition between years, combined with the documented yearly changes in dominant biota cover (Figs. 6 and 7) strongly suggest that the sessile community on the jetty rock had not stabilized by the fourth year after construction.

(b). South Jetty

Species composition and structure of the sessile community on the south jetty also changed considerably between sampling periods (Tables 6 and 7, Figs. 9-11). Additionally, many of these changes differed from those noted on the north jetty, primarily because this jetty was sampled seasonally during the first year after construction.

The initial May 1980 assessment documented that the intertidal rocks were still relatively devoid of fauna, and algal coverage in that zone was only moderate (Figs. 9 and 10). The dominant algae were *Porphyra* sp.

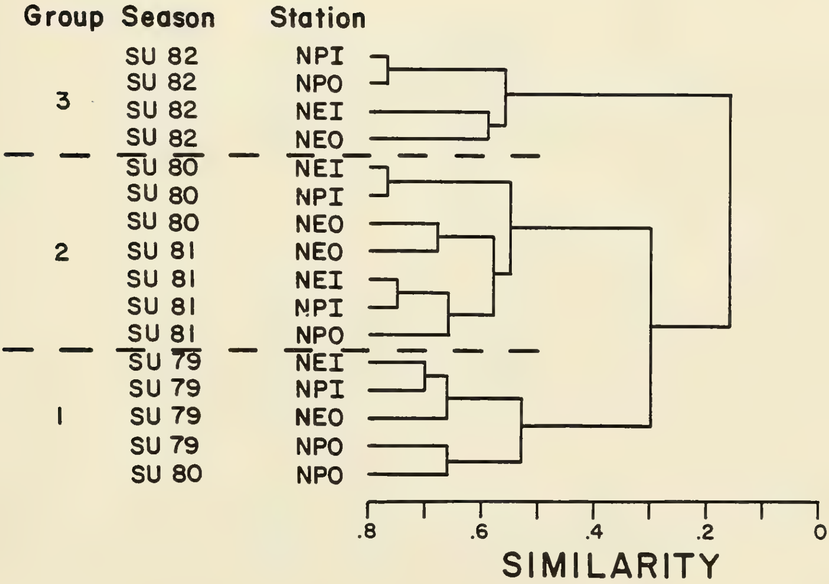

Figure 8. Normal cluster dendrogram of north jetty line-transect data indicating station groups formed using the Bray-Curtis similarity coefficient.

Table 6. Listing of the top ten intertidal and subtidal sessile taxa observed on the south jetty rocks by line-transect census.

RANK	SPRING 1980	SUMMER 1980	FALL 1980	WINTER 1981	SUMMER 1981	SUMMER 1982
			INTERTIDAL			
1	*Porphyra* sp.	Cyanophyta	*Brachidontes exustus*	*Chthamalus fragilis*	*Chthamalus fragilis*	*Chthamalus fragilis*
2	*Enteromorpha* sp.	*Chthamalus fragilis*	*Chthamalus fragilis*	Cyanophyta	*Brachidontes exustus*	*Ulva* sp.
3	*Chthamalus fragilis*	*Brachidontes exustus*	Cyanophyta	*Brachidontes exustus*	Cyanophyta	*Brachidontes exustus*
4	*Balanus improvisus*	*Enteromorpha* sp.	*Crassostrea virginica*	*Crassostrea virginica*	*Gracilaria foliifera*	*Crassostrea virginica*
5	Cyanophyta	*Cladophora* sp.	*Ulva* sp.	*Enteromorpha* sp.	*Crassostrea virginica*	*Hypnea musciformis*
6	*Erythrotrichia carnea*	*Polysiphonia* sp.	*Gracilaria foliifera*	*Gracilaria foliifera*	*Ulva* sp.	Cyanophyta
7	*Polysiphonia* sp.	*Erythrotrichia carnea*	*Lomentaria baileyana*	*Ulothrix flacca*	*Porphyra* sp.	*Bryopsis plumosa*
8	*Bugula neritina*	*Crassostrea virginica*	*Bryopsis plumosa*	*Bangia atropurpurea*	*Balanus eburneus*	*Gracilaria foliifera*
9	*Tubularia crocea*	*Ulva* sp.	*Enteromorpha* sp.	*Callithamnion byssiodes*	*Sabellaria vulgaris*	*Hydroides* sp.
10	*Monostroma oxyspermum*	*Balanus eburneus*	*Cladophora* sp.	*Cladophora* sp.	*Hydroides* sp.	*Balanus venustus*
			SUBTIDAL			
1	*Tubularia crocea*	*Brachidontes exustus*	*Brachidontes exustus*	*Brachidontes exustus*	*Brachidontes exustus*	
2	*Polysiphonia* sp.	*Bugula neritina*	*Clavelina* sp.	*Bugula neritina*	*Gracilaria foliifera*	
3	*Sabellaria vulgaris*	*Sabellaria vulgaris*	*Hydroides* sp.	*Hydroides* sp.	*Obelia geniculata*	
4	*Electra monostachys*	*Polysiphonia* sp.	*Obelia dichotoma*	*Balanus venustus*	*Perophora viridis*	
5	*Alcyonidium polyoum*	*Lomentaria baileyana*	*Sabellaria vulgaris*	*Clavelina picta*	Porifera	
6	*Schizoporella errata*	*Molgula manhattensis*	*Lomentaria baileyana*	*Amathia distans*	*Hydroides* sp.	
7	*Bugula neritina*	*Enteromorpha* sp.	*Codium decorticatum*	*Porphyra* sp.		
8	*Balanus improvisus*	*Hydroides* sp.	*Haliclona loosanoffi*	*Lomentaria baileyana*		
9	*Arbacia punctulata*	*Membranipora tenuis*	*Bugula neritina*	*Hypnea musciformis*		
10	*Asterias forbesii*	*Obelia dichotoma*	*Membranipora tenuis*	*Enteromorpha* sp.		

Table 7. Listing of the top ten intertidal and subtidal sessile taxa observed on the south jetty rocks by photographic census.

RANK	SPRING 1980	SUMMER 1980	FALL 1980	WINTER 1981	SUMMER 1981	SUMMER 1982
			INTERTIDAL			
1	*Porphyra* sp.	*Brachidontes exustus*	*Chthamalus fragilis*	*Brachidontes exustus*	*Chthamalus fragilis*	*Chthamalus fragilis*
2	*Enteromorpha* sp.	*Chthamalus fragilis*	*Brachidontes exustus*	*Chthamalus fragilis*	*Brachidontes exustus*	*Ulva* sp.
3	*Chthamalus fragilis*	*Enteromorpha* sp.	*Crassostrea virginica*	*Crassostrea virginica*	*Crassostrea virginica*	*Crassostrea virginica*
4	*Ulva* sp.	*Cladophora* sp.	*Balanus eburneus*	*Enteromorpha* sp.	*Ulva* sp.	*Hypnea musciformis*
5	*Balanus* sp.	*Ulva* sp.	*Ulva* sp.	*Gracilaria foliifera*	*Gracilaria foliifera*	*Brachidontes exustus*
6	*Balanus eburneus*	*Crassostrea virginica*	*Gracilaria foliifera*	*Rhodymenia pseudopalmata*	*Porphyra* sp.	*Bryopsis plumosa*
7	*Polysiphonia* sp.	*Balanus eburneus*	*Balanus* sp.	*Balanus improvisus*	*Hydroides* sp.	*Enteromorpha* sp.
8		*Hypnea musciformis*	*Balanus improvisus*		*Hypnea musciformis*	*Gracilaria foliifera*
9		*Polysiphonia* sp.			*Lomentaria baileyana*	*Hydroides* sp.
10		*Sabellaria vulgaris*			*Sabellaria vulgaris*	*Sabellaria vulgaris*
			SUBTIDAL			
1	*Tubularia crocea*	*Brachidontes exustus*	*Brachidontes exustus*	*Brachidontes exustus*	*Brachidontes exustus*	
2	*Bugula neritina*	*Bugula neritina*	*Clavelina picta*	*Clavelina picta*	*Gracilaria foliifera*	
3	*Schizoporella errata*	*Hydroides* sp.	*Leptogorgia virgulata*	*Bugula neritina*	*Ulva* sp.	
4	*Hydroides* sp.	*Molgula manhattensis*	*Codium decorticatum*	*Membranipora tenuis*	Porifera	
5		*Perophora viridis*	Ascidiacea	*Hydroides* sp		
6		*Sabellaria vulgaris*	*Halocordyle disticha*	*Ulva* sp.		
7		*Schizoporella errata*	*Schizoporella errata*	*Tubularia crocea*		
8		*Astyris lunata*	*Asterias forbesii*			
9		*Balanus venustus*	*Sabellaria vulgaris*			
10		*Balanus* sp.	*Hydroides* sp.			

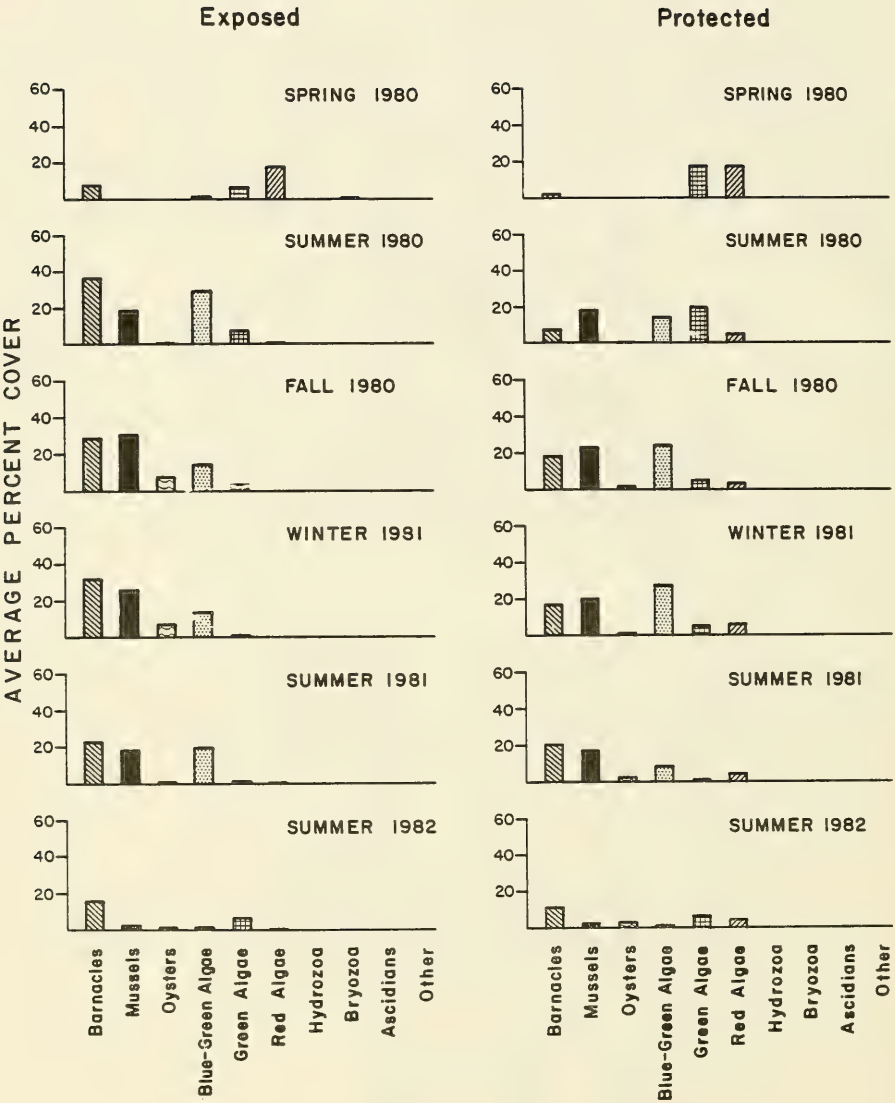

Figure 9. Line-transect estimates of mean percent cover for the different sessile taxa found on the intertidal south jetty rocks. Histograms represent means from the 2.0-m to MLW intertidal levels.

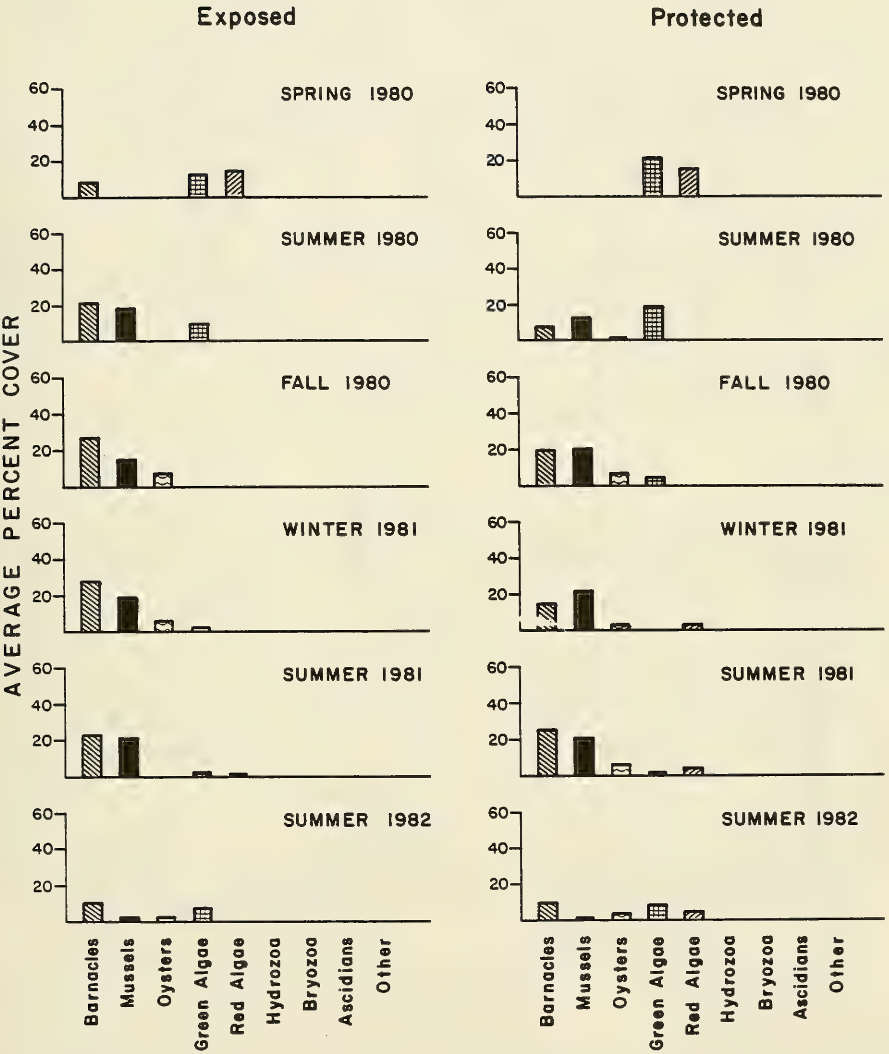

Figure 10. Photographic estimates of mean percent cover for the different sessile taxa found on the intertidal south jetty rocks. Histograms represent means from the 2.0-m to MLW intertidal levels.

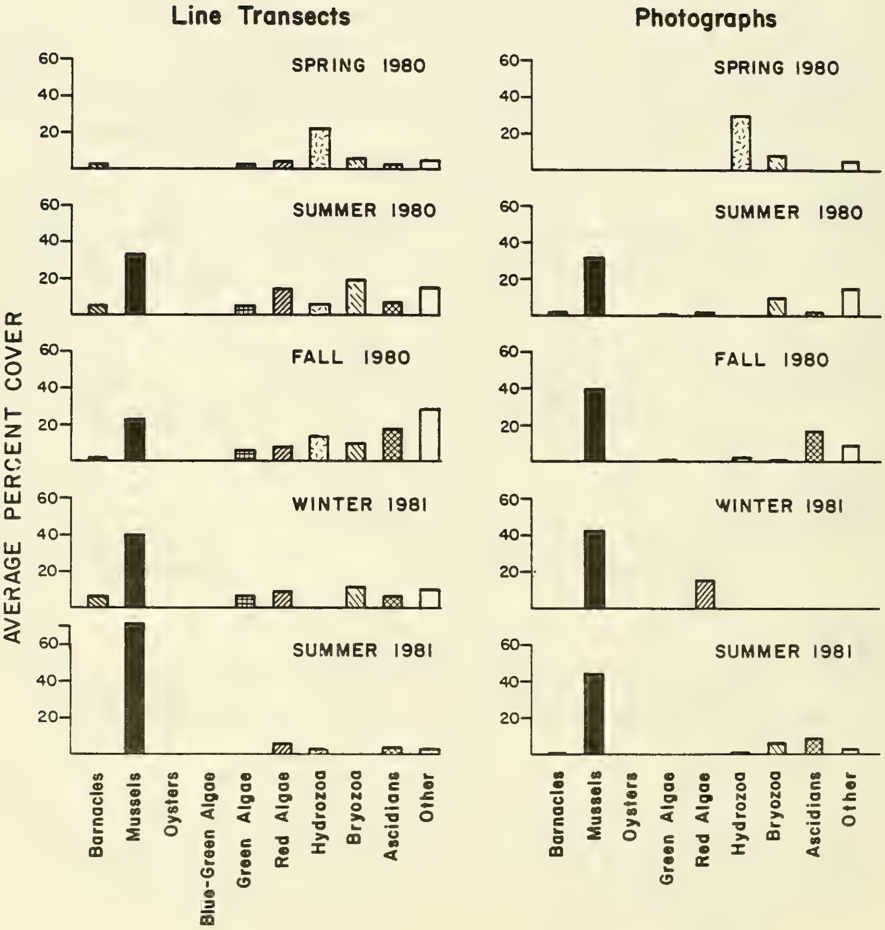

Figure 11. Line-transect and photographic estimates of the mean percent cover for the different sessile taxa found at the -1.0-m subtidal level on the protected side of the south jetty.

and *Enteromorpha* sp. (Tables 6 and 7). Kapraun and Zechman (1982) also noted these genera colonizing North Carolina jetty rocks during the winter and early spring months. Two barnacle species, *Chthamalus fragilis* and *Balanus improvisus*, the hydroid *Tubularia crocea*, and the bryozoan *Bugula neritina* were the only fauna found on the rocks in May. Larval recruitment of these species is known to begin in the cooler water temperatures which prevailed at Murrells Inlet during the period preceding first sampling (Woods Hole Oceanographic Institution, 1952; Sutherland and Karlson, 1977), thus accounting for their presence.

Three months later biota coverage had increased considerably. The most abundant three organisms (Cyanophyta, *C. fragilis*, and *B. exustus*), which had settled on the rocks during the intervening period, were the same as those noted on the north jetty at that time (Tables 4 and 6). *Chthamalus fragilis* and blue-green algae were more prevalent on the exposed side during that summer, but by autumn, this difference between sides was reduced. Mussel coverage also increased during the summer months of 1980, reaching peak densities on both sides by November (Figs. 9 and 10). Mussels, barnacles and blue-green algae continued to dominate the community in terms of rock coverage until the summer of 1982 when coverage by most taxa declined.

Reduced biota coverage on the rocks in 1982 reflected, in part, the reduced number of intertidal levels which could be sampled in that year. For example, coverage of the intertidal rocks by the mussel *B. exustus* appears to be considerably less in 1982 as compared with the preceding sampling periods (Figs. 9 and 10). However, this species was observed only in the lower portion of the intertidal zone on both jetties, and these sampling levels were buried in sand at the inner stations (SPI, SEI) by 1982. Additional causes for the reduced biota cover observed on this jetty may include such factors as competition, predation, and natural mortality. Even at stations where the lower levels were not buried, mussel densities had declined considerably at the lower levels by 1982 (Appendices C and D). Additionally, although the rocks at higher intertidal levels appeared to be covered with barnacles, close inspection revealed that most were just shell plates from dead adults and the majority of living specimens were newly settled juvenile forms. The natural life span of the dominant species, *C. fragilis*, is not known for this area. However, a 2- to 3-year life span has been noted for other barnacle species (Woods Hole Oceanographic Institution, 1952), which correlates well with the mortality noted on the south jetty.

As noted for the north jetty biota, subtidal fauna and flora on the south jetty rocks changed considerably over the study period (Tables 6 and 7, Fig. 11). Three months after completion of rock emplacement, several species had colonized the rocks, but the hydroid *Tubularia crocea* dominated in terms of faunal cover. The peak settling period for this species is during the spring (Woods Hole Oceanographic Institution, 1952; Sutherland and Karlson, 1977), thus explaining early dominance on the rocks. By summer, *T. crocea* had disappeared from the rocks, probably because this species undergoes cycles of activity in temperate areas of the western Atlantic, and it is inactive during the summer in South Carolina (Calder, unpublished).

During the summer of 1980, the mussel *Brachidontes exustus* covered more than 50% of the subtidal rock space at station SPO, whereas the bryozoan *Bugula neritina* and the red algae *Lomentaria baileyana* were more prevalent at station SPI (Appendix C). These differences probably reflect the different duration of rock submergence at these sites as noted for the north jetty stations. Other fauna commonly found in the subtidal zone during this season included the polychaetes *Sabellaria vulgaris* and *Hydroides* sp. (mostly *H. dianthus*), the ascidians *Molgula manhattensis* and *Perophora viridis*, the barnacles *Balanus* spp., and the encrusting bryozoans *Schizoporella errata* and *Membranipora tenuis* (Tables 6 and 7).

Mussels continued to dominate the subtidal rocks at SPO for the remainder of the study, generally covering more than 70% of the rocks. At SPI, on the other hand, ascidians, serpulid polychaetes, and hydroids formed the dominant biota cover (Appendices C and D). With few exceptions, the subtidal community composition at both south jetty stations was not very similar to equivalent areas on the north jetty during the same sampling periods, or after equivalent periods of rock submergence. This was particularly evident for the algal component, which dominanted biota cover on the north jetty rocks during 1981 and 1982, but not on the south jetty where algae were rarely observed.

Cluster analysis of south jetty data confirms that some seasonal and yearly changes occurred in the jetty community composition (Fig. 12), but the differences are not as clear as those noted on the north jetty. Stations sampled during the first season (Group 1) had relatively dissimilar faunal and floral composition to all other station collections. As noted previously, biota cover on the rocks at this time was relatively depauperate, thus accounting for this separation of collections. Station groupings from most later collections did not indicate any distinct seasonal separation (Groups 2-4), but it is interesting to note that within those groups, collections from the protected side often grouped separately from collections on the exposed side. This is most probably due to the presence of subtidal fauna and flora at the protected sites as compared with the exposed side where waters were too shallow to sample subtidally.

(3). Vertical Zonation Patterns

Obvious gradients were observed in the vertical distribution of most species found on the north and south jetties (Figs. 13 and 14). These distribution patterns were generally similar over the entire study period, with only minor differences noted between sides (Appendices A-D).

Rocks at 2.5 m above MLW were usually devoid of any biota since this level was well above the mean high water mark. Only occasional small patches of blue-green algae were noted. These patches were probably established during periods of heavy wave swell (e.g. storms), but they appeared to be short lived based on observations during subsequent sampling periods.

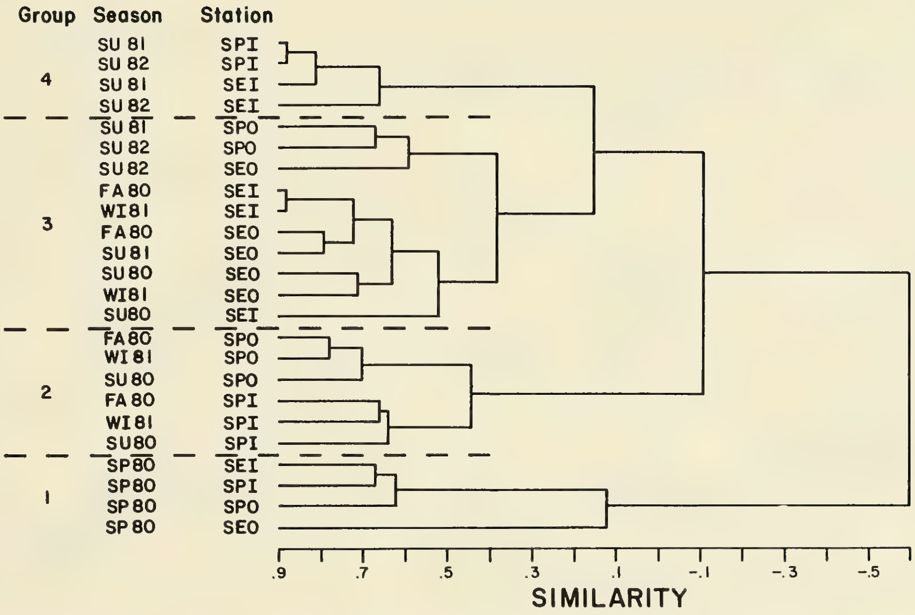

Figure 12. Normal cluster analysis of south jetty line-transect data indicating station groups formed using the Bray-Curtis similarity coefficient.

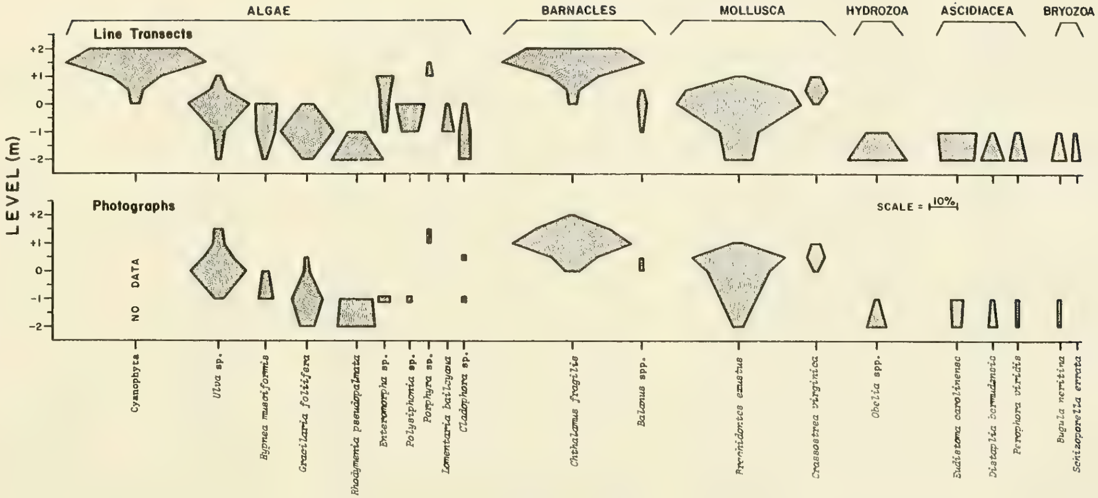

Figure 13. Vertical distribution of the 20 most abundant sessile species observed at north jetty stations. Estimates represent mean values from all stations over the four-year period.

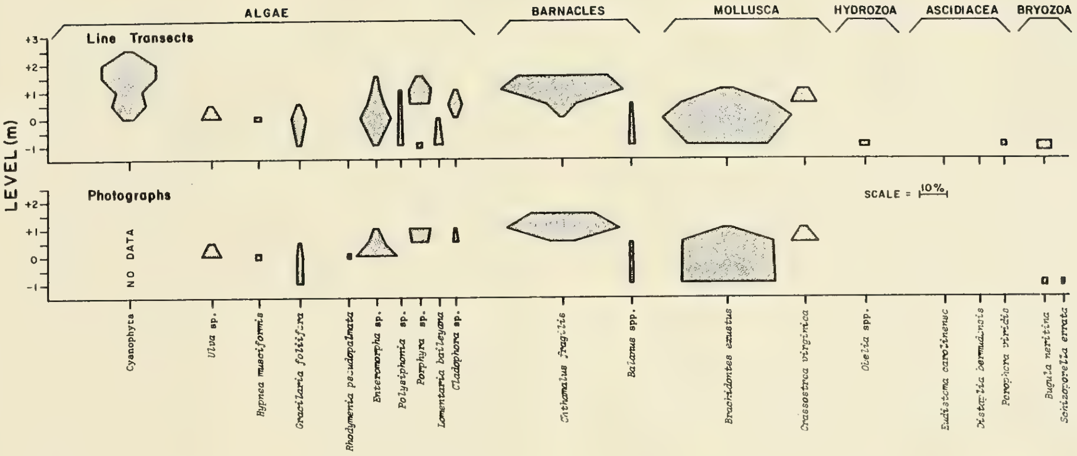

Figure 14. Vertical distribution of the 20 most abundant sessile species observed at south jetty stations. Estimates represent mean values from all stations over the three-year period.

Blue-green algae cover increased considerably at the next two lower levels, becoming the dominant biota cover at 2.0 m above MLW (Figs. 13 and 14). As noted previously, the common blue-green algal species observed on the rocks throughout the study were *Microcoleus lyngbyaceous*, *Calothrix crustacea*, and *Anacystis aeruginosa*. The combined cover of these species was usually dense enough to form a thick "black-colored" band on the rocks. The only macroinvertebrates noted at 2.0 m above MLW were the barnacles *Chthamalus fragilis*, but average coverage of this species was quite low at this level.

Chthamalus fragilis density was much greater at 1.5 m above MLW and this species was often the only fauna present on the rocks at this level. The barnacles were usually coated with blue-green algae which often obscured them when observed from a distance. Other algae occasionally observed at the 1.5-m level were *Porphyra* sp. and *Enteromorpha* sp.

Maximum densities of *C. fragilis* were observed at 1.0 m above MLW. At this level, other species which had been either rare or absent at higher levels were also present on the rocks. These included the mussel *Brachidontes exustus*, the oyster *Crassostrea virginica*, and the algae *Ulva* sp., *Enteromorpha* sp., *Polysiphonia* sp., *Porphyra* sp. and *Cladophora* sp. Only *Porphyra* sp. reached its maximum cover at this level. All other species were more common at lower intertidal levels. Although blue-green algae were still present at 1.0-m above MLW, their percent cover was considerably reduced as compared with their coverage at higher levels.

Major changes occurred in the sessile community between the 1.0-m and 0.5-m levels, primarily due to a change from barnacle to mussel dominance. During the earlier stages of jetty community development, the 0.5-m rocks were covered by dense mats of *B. exustus* and numbers of *C. fragilis* were greatly reduced. Although mussel density decreased during later years, mussels were still abundant at this level and at MLW. *Chthamalus fragilis* was rare or absent at the 0.5-m level during the first sampling period on both jetties, but more numerous later on the bare rock space that was opened when mussel density declined. Another barnacle, *Balanus eburneus*, was also present on the rocks at 0.5 m and the oyster *C. virginica* was most common at this level (Figs. 13 and 14).

The number of sessile species attached to the rocks increased substantially at the MLW level (Appendices A-D), although mussels still heavily dominated the rocks. When mussel density declined with time, algal growth on the rocks increased and generally filled the bare rock spaces. Species which reached peak abundance at this level included the green algae *Ulva* sp. and *Enteromorpha* sp., and the red algae *Hypnea musciformis*, *Polysiphonia* sp., and *Gracilaria foliifera*. Blue-green algae were least abundant at this level and were rarely observed below MLW. Oysters and barnacles were also common at MLW but *C. fragilis* was replaced by *Balanus* spp., primarily *B. eburneus*.

Gradients in the vertical distribution of most species found subtidally were less pronounced, mostly because there were fewer differences in the physical environment between levels of that zone. However, it is important to note that many of the taxa observed at subtidal levels, such as hydroids, bryozoans and ascidians, were present in only that zone. This is due, in part, to their inability to tolerate desiccation and other stresses present in the intertidal zone. In the first year, *B. exustus* was extremely abundant on the subtidal rocks, particularly at the outer stations which had been submerged for the least period of time. As noted previously, when mussel density declined, algae, ascidians, bryozoans and hydroids became more prominent on the rocks at both levels. Generally, green algae were more prevalent at the shallower depths where better light penetration occurred (Fig. 13). Red algae species were also common at that level and at the -2-m level where green algae were rarely observed. Most hydroid, bryozoan, and ascidian species were also slightly more common at the -2-m level where algae cover on the rocks was not as dense. Some exceptions to this trend were the hydroids *Obelia geniculata* and *O. dichotoma*, which were most often observed growing on the red algae *G. foliifera* and *R. pseudopalmata*. On the channel side of the rocks, light penetration was generally lower and algae were not as abundant. As a result, hydroids, bryozoans, and ascidians were more common at shallower depths on that side than the wave-exposed side (Appendices A-D).

(4). General Discussion

Community composition and patterns of vertical zonation resembled those described from the jetties at Charleston, South Carolina, by Stephenson and Stephenson (1952, 1972). They reported finding the barnacle *Chthamalus fragilis* in the black band of blue-green algae and lichens marking the splash zone (supralittoral fringe). Peak abundances of this barnacle were found high in the intertidal zone. Mussels *(Brachidontes exustus)*, reported in "colossal quantities," oysters *(Crassostrea virginica)*, and balanid barnacles *(Balanus eburneus, B. improvisus)* were the dominant invertebrates in the middle and lower intertidal zones. Although mussels and balanid barnacles were also abundant near MLW on the Murrells Inlet jetties, oysters were not always common. Other invertebrates reported near MLW on the Charleston jetties included the gastropod *Urosalpinx cinerea*, the scleractinian coral *Oculina arbuscula*, the ascidian *Molgula manhattensis*, the asteroid *Asterias forbesii*, the echinoid *Arbacia punctulata*, the hydroid *Tubularia crocea*, the bryozoans *Anguinella palmata*, *Electra monostachys*, and *Membranipora tenuis*, the actiniarian *Bunodosoma cavernata*, and a red sponge believed to be *Hymeniacidon heliophila*.

Many factors, both biotic and abiotic, influence epifaunal community structure and development on rocky shores. Although biotic factors have not been ignored, most descriptive investigations have attributed distributional patterns largely to abiotic factors such as wave exposure, tides, desiccation, climate, temperature, light intensity, width of the rocky tract, proximity of sand, and rock composition, texture, and configuration (see Stephenson and Stephenson, 1972; Lewis, 1972; Newell, 1979). Experimental research, beginning with Connell (1961a,b; 1970) and including studies such as those of Paine (1966, 1969, 1974), Dayton (1971, 1975), Menge (1976), Lubchenco and Menge (1978), and others, has emphasized biological interactions such as predation and inter- and intra-specific competition in community development and species distribution.

Such studies generally support the hypothesis that the lower limits of intertidal species are mainly biologically controlled while upper limits are more likely set by abiotic factors (Connell, 1972). Lewis (1977) cautioned that neither biological nor physical factors should be underestimated in the distribution of rocky shore communities.

At Murrells Inlet, physical stress most likely controlled the upper limits of *Chthamalus fragilis* and blue-green algae; no evidence of significant barnacle predation was observed at the higher levels. Although not tested, we believe the lower distribution of *C. fragilis* may be limited by competition for space with *B. exustus*, which formed dense mats of biota at 0.5 m above MLW. The relative distribution of both these species parallels that noted by Menge (1976) for *Balanus balanoides* and *Mytilus edulis* in a New England rocky intertidal system. Even when mussel density declined with time, other dominant forms replaced mussels on the bare rock space and it is likely that *C. fragilis* was still competitively excluded.

The upper distribution of the mussels *B. exustus* and algae *Ulva* sp., *Hypnea musciformis* and *Gracilaria foliifera* also appeared to be regulated by physical factors since the mat of mussels stopped abruptly just above the 0.5-m level and the algae were rarely found above MLW even though there was space available for all these species to colonize the rocks. Within the intertidal and subtidal zones covered by *B. exustus*, mussel density may have been influenced by biotic factors. Intertidally, large numbers of birds, particularly overwintering ruddy turnstones and various species of gulls, were observed on the jetties during February. These birds were seen feeding around jetty rocks, and shell fragments of *B. exustus* were abundant in bird excrement on the jetties. Subtidally, the mussel predator *Asterias forbesii* was often observed on the rocks, apparently feeding on *B. exustus*. Therefore, it is likely that the decline in mussel density after the first year was due to predation since the natural life span of most mussels is longer than one year (Woods Hole Oceanographic Institution, 1952) and mussels are generally competitive dominants in rocky intertidal systems (Paine, 1974; Menge, 1976).

In terms of the overall sessile community composition on the jetty rocks, species composition and vertical distribution patterns in the more physically stressed intertidal zone appear to have approached relative stability quickly. The well-defined bands of blue-green algae, barnacles, oysters and mussels were established within the first 12 months after rock emplacement, and alterations in invertebrate community structure were relatively minor thereafter. Subtidally, epibenthic communities appeared to be less stable over the four-year study. Mussels, which initially dominated the subtidal community, were replaced by bryozoans, ascidians, cnidarians and algae with major changes occurring in the yearly dominance of taxa. Additionally, differences in community composition were observed between jetties in subtidal areas sampled during the same season, and even between sides on the same jetty. These differences were probably due to differences in time of rock submersion and wave exposure (Woods Hole Oceanographic Institution, 1952; Calder and Brehmer, 1967; Connell, 1972; Osman, 1977). However, the observations during this study support Sutherland's (1974) and Sutherland and Karlson's

(1977) contention that a stable "climax" community of sessile invertebrates is not likely to occur.

b. Motile Epifauna

Ranked abundance estimates for all motile macroinvertebrates are provided in Appendix F for the four north-jetty sites and in Appendix G for the four south-jetty sites.

(1). Total Abundance and Number of Taxa

Slurp gun sampling at intertidal and subtidal levels of both jetties resulted in the collection of 131 species over the four-year period. Amphipods, polychaetes and molluscs represented over 70% of all species found on the north-jetty rocks (Table 8). Amphipods alone dominated the motile epifauna on the south jetty, representing approximately 40% of all such species collected. On both jetties, motile biota rapidly colonized the rocks, with densities generally as high in the first sampling period as in subsequent sampling periods (Appendix H). Amphipods and isopods were the two most numerically abundant taxa on both jetties even though only a few isopod species were represented. Over all levels, 11 major taxonomic groups were found on the north jetty and 10 on the south jetty (Table 8).

Both the number of species and the abundance of motile fauna were inversely correlated with tidal elevation at north- and south-jetty stations (Figs. 15 and 16). The increase in species richness and abundance at the lower levels is related to the increased structural complexity of the sessile community at those levels. Dean (1981) found a similar relationship between structural complexity and the number of motile species on a fouling community in North Carolina. Increased environmental stresses probably also played an important role in limiting the motile epifauna at the upper levels (Connell, 1972).

Estimates of species diversity (Appendix H) for the epifaunal assemblages on both jetties paralleled the patterns noted for species number and abundance. However, no discernible trends were observed in these parameters that could be attributed to the effects of differing degrees of exposure (protected versus exposed) or duration of submergence (inner versus outer) of the jetty rocks (Figs. 15 and 16).

(2). Community Composition and Vertical Distribution

Twenty-three species accounted for approximately 90% of the 7,209 animals collected in suction samples. The remaining 10% (806 animals) were distributed among 108 other species. Thirteen of the 23 numerically dominant species were amphipods, four were isopods, three were molluscs, and three represented other taxa (Fig. 17). With few exceptions, mean densities of these species were greater on the north versus south jetty. This is most likely due to the greater representation of subtidal levels at north-jetty stations, where most of these species were more prevalent. Temporal variations were also observed in the abundance of these species on both the north and south jetties (Figs. 18 and 19).

Table 8. Number of individuals and number of species of each major taxon of motile macroinvertebrates from the north and south jetties.

TAXON	NORTH JETTY				SOUTH JETTY			
	No. of Individuals		No. of Species		No. of Individuals		No. of Species	
	Total Number	Percent of Total	Total Number	Percent of Total	Total Number	Percent of Total	Total Number	Percent of Total
Amphipoda	2183	53.6	25	21.0	2313	73.7	24	38.1
Isopoda	742	18.2	6	5.0	498	15.9	6	9.5
Mollusca	481	11.8	28	23.5	215	6.8	7	11.1
Polychaeta	242	5.9	32	26.9	58	1.8	12	18.8
Decapoda	209	5.1	17	14.3	26	0.8	7	11.1
Echinodermata	159	3.9	4	3.4	2	0.1	1	1.6
Nemertinea	25	0.6	1	0.8	17	0.5	1	1.6
Nematoda	11	0.3	1	0.8	3	0.1	1	1.6
Pycnogonida	8	0.2	3	2.5	7	0.2	3	4.8
Turbellaria	5	0.1	1	0.8	0	0	0	0
Sipunculida	4	0.1	1	0.8	0	0	0	0
Mysidacea	0	0	0	0	1	<0.1	1	1.6
TOTAL	4069		119		3140		63	

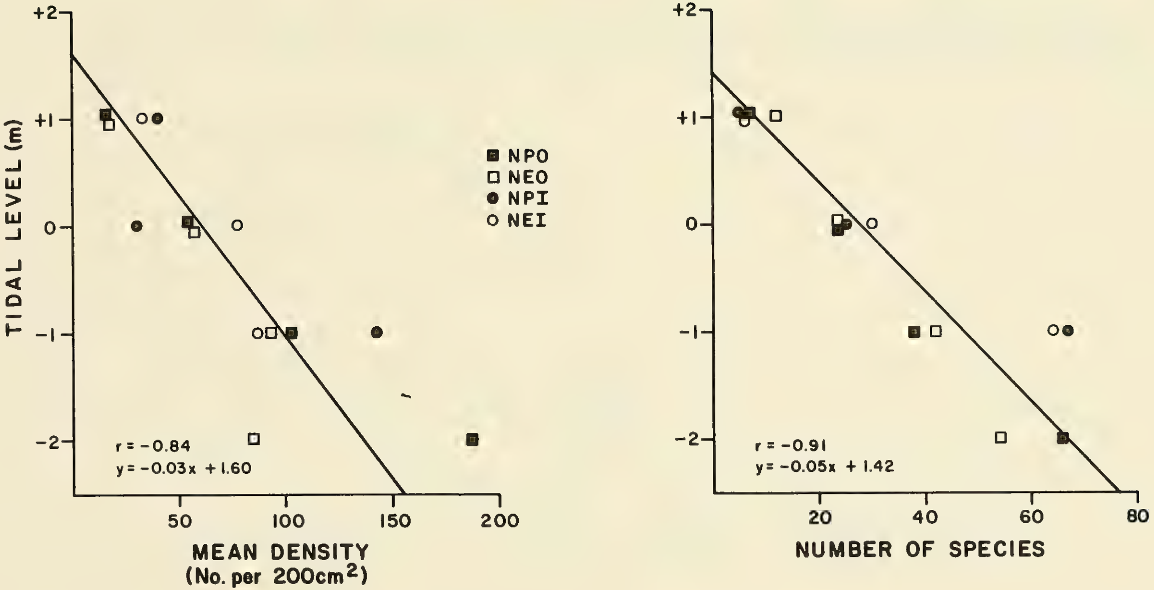

Figure 15. Linear regression of the abundance and number of species of motile epifauna at each north jetty station as a function of tidal elevation.

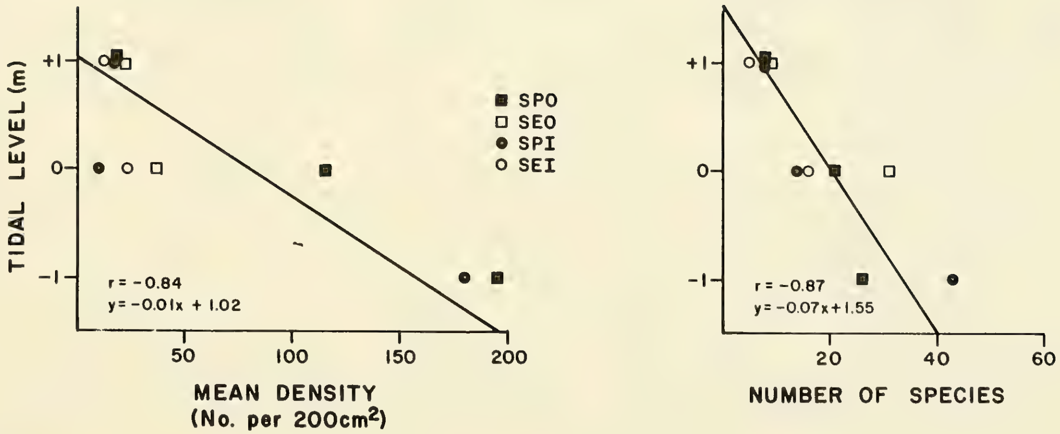

Figure 16. Linear regression of the abundance and number of species of motile epifauna at each south jetty station as a function of tidal elevation.

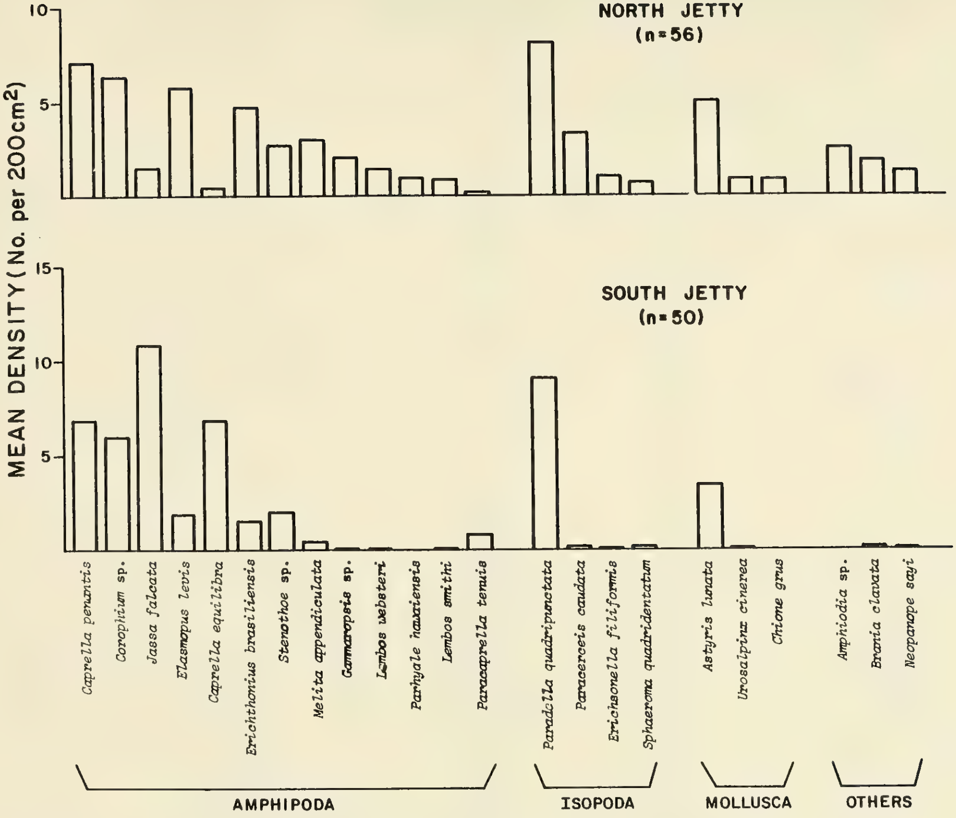

Figure 17. Estimates of overall mean density for the dominant motile macroinvertebrates of both jetties. Species which contributed greater than 1% of the total number on either jetty are included.

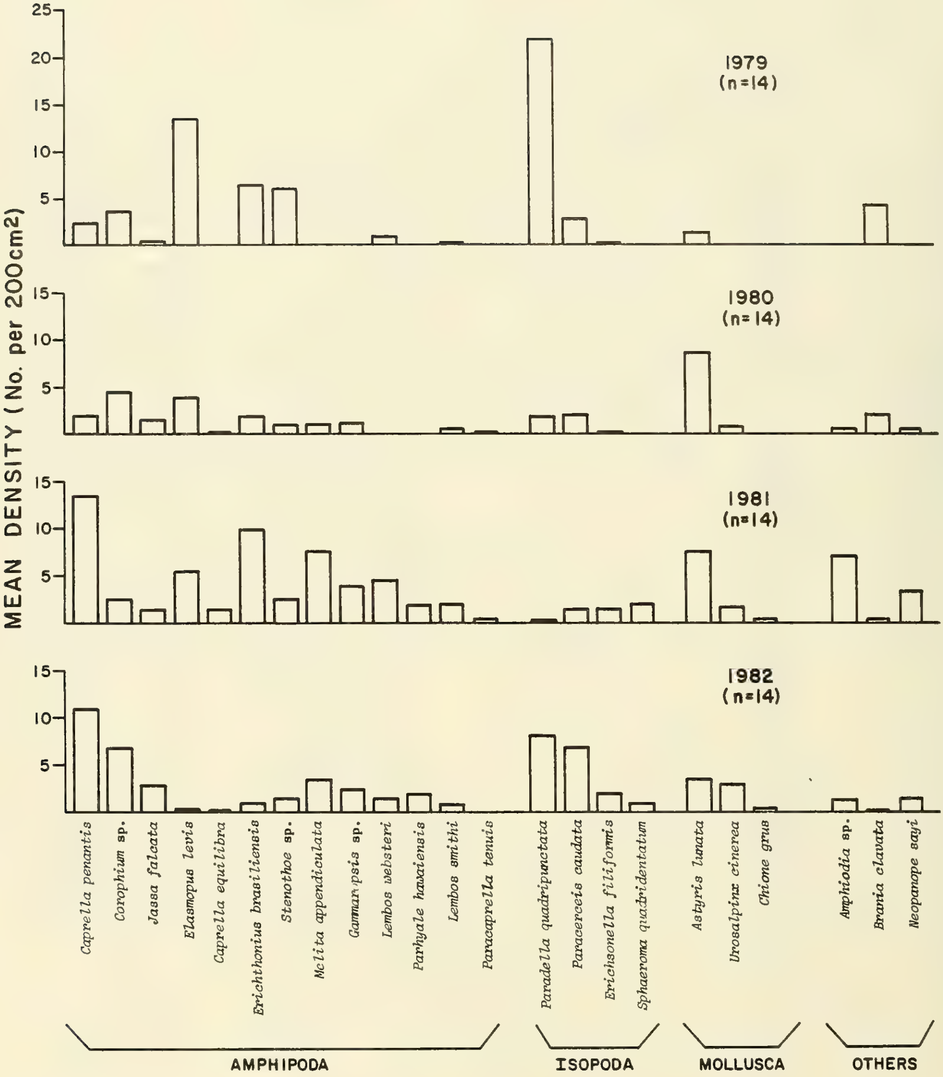

Figure 18. Annual changes in the density of dominant motile macroinvertebrates from the north jetty. Estimates represent mean values from all stations during a particular year.

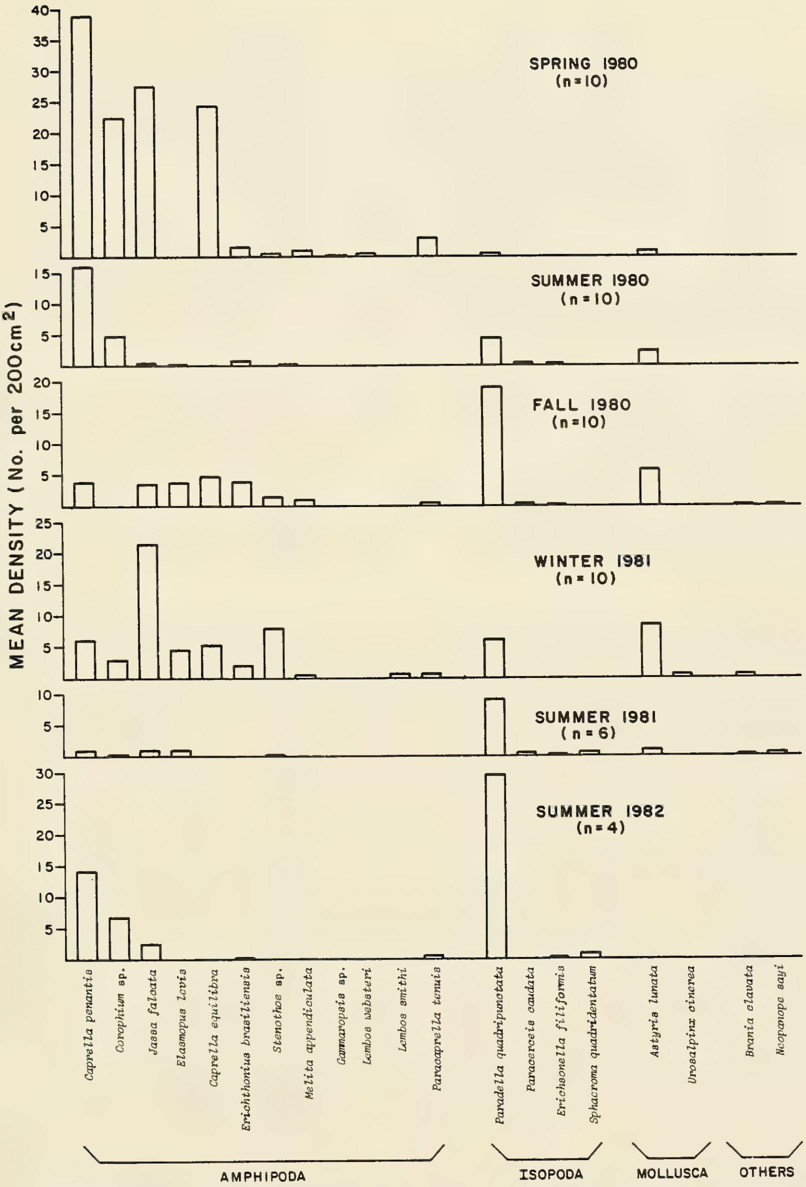

Figure 19. Seasonal and annual changes in the density of dominant motile macroinvertebrates from the south jetty. Estimates represent mean values from all stations during a particular season.

(a). North Jetty

Samples collected during the first summer after north-jetty construction contained only 13 of the 23 dominant species, two of which, *Paradella quadripunctata* and *Elasmopus levis*, were substantially more abundant than the others (Fig. 18). *Paradella quadripunctata* reached maximum abundance at the +1-m level and was largely restricted to the intertidal zone (Fig. 20). It has previously been recorded only from Puerto Rico (Bowman, pers. comm.), where it was commonly found on red algae in rocky intertidal environments (Menzies and Glynn, 1968). The other dominant, *E. levis*, was found at all levels, but it was most abundant at the MLW and -1-m levels. This species is a known inhabitant of rocky intertidal and shallow-water zones of New England and the Gulf of Mexico (Bousfield, 1973; McKinney, 1977).

Densities of both *P. quadripunctata* and *E. levis* were greatly reduced by the summer of 1980, and remained low for the rest of the study period (Fig. 18). An increase occurred in the number of species collected during the second year, with 19 of the 23 most abundant species being present. However, the densities of most of these species were lower than in other years, with the exception of the gastropod *Astyris lunata*. This mollusk is a common inhabitant of shallow coastal waters of South Carolina (Zingmark, 1978), and was most abundant at subtidal levels (Fig. 20).

By 1981, densities of most species had increased and all of the 23 dominants were present on the rocks (Fig. 18). *Astyris lunata* remained abundant, but three species of amphipods were even more common. *Caprella penantis*, morphologically adapted for clinging to fouling biota (Bynum, 1978), was most abundant at the subtidal levels, as were *Erichthonius brasiliensis* and *Melita appendiculata*. The latter two species reached maximum densities during 1981 along with the ophiuroid *Amphiodia* sp.

All but one of the 23 dominant species were still present on the jetty rocks during the last sampling period. *Caprella penantis* remained the most abundant species and, together with the amphipod *Corophium* sp. (probably *C. ascherusicum*) and two species of isopods (*P. quadripunctata* and *Paracerceis caudata*), numerically dominated the motile fauna (Fig. 18). The two morphologically similar sphaeromatid isopods, *P. quadripunctata* and *P. caudata*, showed considerable niche separation, with the former being found in the intertidal region and the latter being largely restricted to the subtidal zone (Fig. 20). Menzies and Glynn (1968) also reported that *P. caudata* occurred mainly among algae, seagrass, sponges and the like in subtidal waters. *Corophium* sp. showed significantly greater abundance on the protected side of the north jetty than on the exposed side ($p < 0.05$, Mann-Whitney U-test), but was the only dominant species to show a significant difference.

Cluster analysis of north jetty suction data provides further evidence of annual changes in overall community structure of the motile epifauna (Fig. 21). Collections from the four stations sampled in 1979 grouped

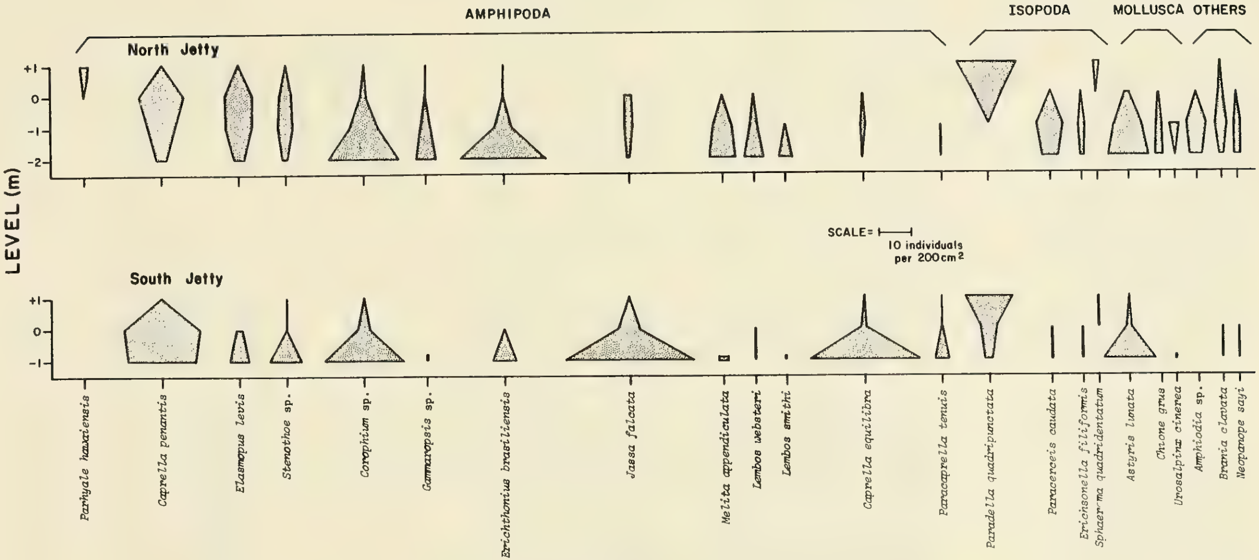

Figure 20. Vertical distribution of the dominant motile macroinvertebrates on both jetties. Estimates represent mean densities from all stations and sampling periods combined.

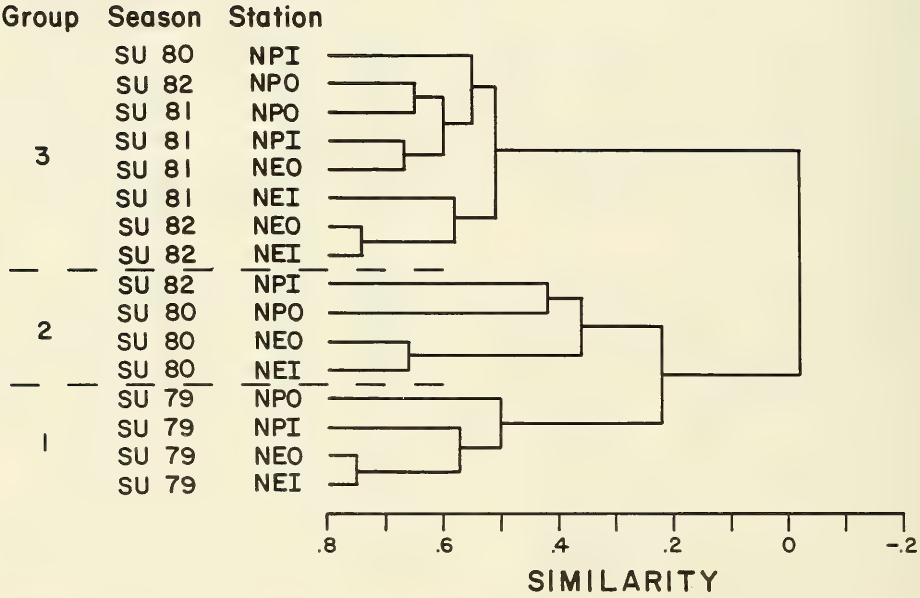

Figure 21. Normal cluster dendrogram of north jetty suction data indicating station groups formed using the Bray-Curtis similarity coefficient.

together (Group 1) and were relatively dissimilar to those obtained in later years. For the most part, 1980 samples were also relatively similar to one another (Group 2) and relatively dissimilar to the other groups. Collections from 1981 and 1982 formed Group 3, indicating higher similarity of faunal composition during these later years as compared with earlier years. This suggests that the initial changes in the motile community were more significant than those in later years. Differences in faunal similarity on wave-exposed versus protected sides were not pronounced.

(b). South Jetty

Four species of amphipods were the only abundant motile fauna on the south jetty during the spring of 1980, shortly after construction was completed. These amphipods were generally restricted to MLW and below (Fig. 20), and their densities were greater than those for other species during any sampling period, with the exception of *Paradella quadripunctata* (Fig. 19). Dense mats of the hydroid *Tubularia crocea* occurred during this season (Appendices C and D), supporting very high densities of the caprellids *C. penantis* and *C. equilibra*, and the tubicolous gammarids *Jassa falcata* and *Corophium* sp. Bynum (1978) also noted an association between this hydroid and *C. penantis* in North Carolina waters. Other species found during the spring were very low in abundance (Fig. 19).

By the following summer, all of the initially dominant species had declined considerably, in number, and only *C. penantis* remained at moderate densities. Most of the other species collected during this season were rare, and only 10 of the 23 dominant species were present. Much of this decline may be attributed to decreased coverage by *T. crocea*, which was present only when water temperatures were low. Differences in the relative abundance of motile species were also noted between the north and south jetties during this season (Figs. 18 and 19).

Dominance continued to change during the fall and winter seasons, with *P. quadripunctata* being most abundant during the fall and *J. falcata* dominating during winter. *Astyris lunata* was also relatively common during both seasons, as were a number of amphipod species. Many of these seasonal changes are attributable to the reproductive periodicities of the motile species, and to changes in dominance of sessile taxa (Figs. 9 and 11).

During the last two years, the high intertidal isopod *P. quadripunctata* was the most abundant species (Figs. 19 and 20), and it was frequently observed in the empty tests of the barnacle *C. fragilis*. Shoaling had occurred around the south jetty by this time, resulting in the loss of most lower sampling levels. As a consequence, the decreased abundance of the other dominants (generally most common subtidally) was probably not strictly a function of temporal change, but largely reflected this intertidal sampling bias.

The poor representation of subtidal levels on the south jetty also obscured the interpretation of cluster analysis of the suction data from this jetty. No clear patterns of temporal or spatial similarity were observed, and as a result, the cluster dendrogram is not presented here.

(3). General Discussion

Numerous studies have assessed the sessile component of fouling communities in rocky intertidal and subtidal habitats (see Connell, 1972; Paine, 1974 for reviews), but few have examined the highly motile epifauna associated with those fouling communities (Dean, 1981). This study provided the opportunity to characterize the species composition, distribution, and abundance of the motile macroinvertebrates on both jetties, and to relate these to the development of the sessile community.

Similarities were observed in the patterns of temporal change in abundance, dominance, and species composition between the motile epifauna and the sessile biota of the jetties. Both of these biotic components achieved high overall densities relatively quickly, particularly on the south jetty. The dense stands of *T. crocea,* which generally develop in this geographic area only during periods of low water temperature (Woods Hole Oceanographic Institution, 1952) provided excellent habitat during the spring of 1980 for several species of motile amphipods, including *C. penantis.* This amphipod is reproductively adapted to rapidly colonizing habitats which undergo frequent reduction in the density of the sessile inhabitats (Bynum, 1978) such as that observed for *T. crocea.*

Increased faunal richness at the subtidal levels as compared with the intertidal zone was also observed within both the motile and sessile communities. Dean (1981) noted that the richness of motile species was positively correlated with the richness of the sessile species in the fouling community he investigated. Similarly, the structurally complex community of sessile species, such as ascidians, bryozoans, hydroids, and algae found at subtidal levels on the Murrells Inlet jetties, enhanced the development of a diverse assemblage of motile species. Dean (1981) also described a negative correlation between motile species richness and dominance of the sessile fauna by one or a few species. The overwhelming dominance by *Chthamalus fragilis* at upper intertidal levels is not conducive to the development of a rich motile epifaunal community at those levels on the jetties investigated in this study, where *P. quadripunctata* was the only abundant motile species.

Certain differences were noted in the development of the sessile and motile communities on the jetties. For example, the number of motile species on the jetties increased over time, but the number of sessile species was relatively constant during the study period. Furthermore, the vertical zonation observed among the sessile species was not as well defined for the motile forms. The distinct bands of sessile organisms are a result of the sedentary nature of these organisms and their competition for space in suitable environmental conditions. The motility of free-living organisms, on the other hand, allows them to migrate over a wide vertical range during periods of submergence.

c. Jetty Fishes

(1). Species Composition

A list of the fish species observed or collected near the jetties is presented in Table 9. Many of the species were found only in the gill nets placed on sand bottom near the jetties, and it is likely that most of those fishes would have been captured even if the jetties were not present. Even so, jetties are known to serve as excellent artificial reefs, increasing both the abundance and diversity of ichthyofauna in areas where they are present (Hastings, 1972, 1978; Hurme, 1979).

A large number of fishes were observed on or near the jetty rocks while scuba diving. The two species most frequently seen were the crested blenny *(Hypleurochilus geminatus)* and black sea bass *(Centropristis striata)*. Both species are commonly associated with reefs (Parker et al., 1979; Powles and Barans, 1980; Middleditch, 1981), and black sea bass are recreationally as well as commercially important in South Carolina waters. The majority of *C. striata* seen on the jetty rocks were juveniles, suggesting that this species is utilizing the jetties as a nursery ground. Other recreationally important species frequently encountered around the jetties included sheepshead *(Archosargus probatocephalus)*, Atlantic spadefish *(Chaetodipterus faber)*, spotted seatrout *(Cynoscion nebulosus)*, bluefish *(Pomatomus saltatrix)*, mullet *(Mugil* sp.) and southern flounder *(Paralichthys lethostigma)*.

(2). Food Habits

Data on the food habits of selected fishes is presented in Table 10. With the exception of black sea bass which were easily captured, it was somewhat difficult to obtain sufficient specimens for a thorough analysis of diets. Even so, the analysis of fish stomachs indicated that those species of most recreational importance are utilizing the jetty biota as food.

Black sea bass consumed primarily decapods and small fish which were common on the rocks. The two major species consumed (by volume) were the small crab *Neopanope sayi* and the crested blenny (Table 10). Other important food items included amphipod, isopod and polychaete species which were commonly found on the rocks (Appendices F and G). Decapods and small fishes are also important in the diet of black sea bass found in offshore hard bottom reefs of the South Atlantic Bight (Sedberry and Nimmich, In press).

Spadefish mainly consumed a different component of the jetty prey community based on stomach content analysis (Table 10). Primary food items appeared to be the sessile, colonial forms such as sponges, hydroids, bryozoans and algae. Amphipods were also important in the diet of spadefish, but most amphipods eaten were those commonly found on the colonial taxa, such as *Caprella* spp. Therefore, it is possible that amphipods were only incidentally consumed during feeding on the sessile biota.

Table 9. Species of fishes observed on or near the jetty at Murrells Inlet during field studies, 1979-1982.

SPECIES	Diving	Gill Net	Blackfish Trap	Beach Seine	Hook & Line
Atlantic sharpnose shark (*Rhizoprionodon terraenovae*)		+			
Rays (Family Dasyatidae—species undetermined)	+				
Cownose ray (*Rhinoptera bonasus*)		+			
Atlantic menhaden (*Brevoortia tyrannis*)		+			
Threadfin shad (*Dorosoma petenense*)		+			
Atlantic thread herring (*Opisthonoma oglinum*)		+			
Striped anchovy (*Anchoa hepsetus*)	+			+	
Oyster toadfish (*Opsanus tau*)					+
Black sea bass (*Centropristis striata*)	+		+		+
Bluefish (*Pomatomus saltatrix*)	+	+			
Atlantic bumper (*Chloroscombrus chrysurus*)		+			
Florida pompano (*Trachinotus carolinus*)		+			
Lookdown (*Selene vomer*)	+	+			
Pigfish (*Orthopristis chrysoptera*)			+		
Bluestriped grunt (*Haemulon sciurus*)	+				
Sheepshead (*Archosargus probatocephalus*)	+	+			
Pinfish (*Lagodon rhomboides*)	+				
Spottail pinfish (*Diplodus holbrooki*)	+				
Spotted seatrout (*Cynoscion nebulosus*)		+			
Spot (*Leiostomus xanthurus*)	+	+			
Atlantic spadefish (*Chaetodipterus faber*)	+	+			
Butterflyfish (*Chaetodon* sp.)	+				
Damselfish (*Pomacentrus* sp.)	+				
Tautog (*Tautoga onitis*)	+	+			
Mullet (*Mugil* sp.)	+				
Southern stargazer (*Astroscopus y-graecum*)				+	
Crested blenny (*Hypleurochilus geminatus*)	+				
Feather blenny (*Hypsoblennius hentzi*)	+		+		
Doctorfish (*Acanthurus chirurgus*)	+				
Atlantic cutlassfish (*Trichiurus lepturus*)		+			
Spanish mackerel (*Scomberomorus maculatus*)		+			
King mackerel (*Scomberomorus cavalla*)					+
Southern flounder (*Paralichthys lethostigma*)	+	+			
Northern puffer (*Sphoeroides maculatus*)				+	
Striped burrfish (*Chilomycterus schoepfi*)					+

Table 10. Percent numerical abundance (N), percent volume displacement (V) and index of relative importance (IRI) of food items found in black sea bass (*Centropristis striata*), Atlantic spadefish (*Chaetodipterus faber*), sheepshead (*Archosargus probatocephalus*), bluestriped grunt (*Haemulon sciurus*) and Tautog (*Tautoga onitis*) stomachs.

Taxon	*Centropristis striata*			*Chaetodipterus faber*			*Archosargus probatocephalus*			*Haemulon sciurus*			*Tautoga onitis*		
Prey Item	N	V	IRI	N	V	IRI	N	V	IRI	N	V	IRI	N	V	IRI
Algae															
Algae A							2.0	0.5	62						
Algae B	0.8	0.2	3												
Chlorophyta undetermined				2.2	0.5	55	2.0	1.6	89						
Cladophora sp.							2.0	2.4	109						
Gracilaria foliifera				2.2	2.1	85									
Heterosiphonia sp.				2.2	<0.1	45									
Hypnea musciformis				2.2	1.0	65	2.0	0.1	51	5.6	1.5	702			
Rhodophyta undetermined				2.2	1.1	67	2.0	0.4	59						
Rhodymenia pseudopalmata				2.2	0.8	59									
Sargassum sp.							2.0	19.3	531						
Ulva sp.							2.0	14.5	411	5.6	73.4	7894			
Total Algae	0.8	0.2	3	13.3	5.6	1512	13.7	38.7	3935	11.1	74.8	8596			
Porifera				4.4	75.3	3190									
Cnidaria															
Hydrozoa															
Dynamena cornicina	0.8	<0.1	3	4.4	<0.1	179									
Eudendrium sp.	0.8	<0.1	3	8.9	5.2	1125									
Halocordyle disticha				2.2	1.9	82									
Hebella scandens				2.2	0.1	46									
Obelia dichotoma				2.2	<0.1	45									
Plumularia setacea				2.2	<0.1	45									
Total Hydrozoa	1.7	<0.1	11	22.2	7.2	2945									
Annelida															
Polychaeta															
Arabella mutans	0.8	<0.1	3												
Arabella sp.	0.8	1.3	7												
Hydroides dianthus	0.8	<0.1	3												
Sabellaria vulgaris	3.4	0.3	23												
Total Polychaeta	5.9	1.6	118												
Mollusca															
Pelecypoda															
Brachiodontes exustus							72.6	60.1	9948						
Crustacea															
Copepoda	1.7	<0.1	5												

Table 10. (Continued)

Taxon	*Centropristis striata*			*Chaetodipterus faber*			*Archosargus probatocephalus*			*Haemulon sciurus*			*Tautoga onitis*		
Prey Item	N	V	IRI	N	V	IRI	N	V	IRI	N	V	IRI	N	V	IRI
Cirripedia															
Balanus venustus				6.7	3.1	195									
Chthamalus fragilis							5.9	0.8	332	66.7	24.5	9113			
Total Cirripedia				6.7	3.1	195	5.9	0.8	332						
Isopoda															
Erichsonella filiformis	5.1	0.7	91										50.0	57.1	10714
Paracerceis caudata	1.7	0.2	12							5.6	0.4	595	16.7	22.4	3911
Total Isopoda	6.8	0.9	144							5.6	0.4	595	66.7	79.6	14626
Amphipoda															
Aoridae undetermined	0.8	<0.1	3												
Caprella equilibra	3.4	0.1	43	8.9	<0.1	178				5.6	0.1	565			
Caprella penantis	3.4	<0.1	22	17.8	0.2	360	5.9	0.1	148						
Cerapus tubularis				2.2	<0.1	45									
Elasmopus levis	0.8	<0.1	3												
Erichthonius brasiliensis	4.2	<0.1	54	4.4	<0.1	179									
Gammaridea undetermined	3.4	0.1	43										16.7	2.0	1871
Jassa falcata															
Lembos smithi	3.4	<0.1	32												
Stenothoe sp.	0.8	<0.1	3	2.2	<0.1	45				5.6	0.1	565			
Amphithoe valida										5.6	0.1	565			
Total Amphipoda	21.2	0.4	808	35.6	0.3	2150	5.9	<0.1	148	16.8	0.3	1696	16.7	2.0	1871
Decapoda															
Brachyura undetermined	5.1	4.8	155										16.7	18.4	3503
Natantia undetermined	4.2	11.8	200												
Neopanope sayi	16.1	20.9	924												
Paguridae undetermined	1.7	0.9	16												
Panopeus herbstii	0.8	6.3	22												
Parthenopidae undetermined	1.7	<0.1	11												
Pilumnus sp.	0.8	0.4	4												
Pilumnus dasypodus	0.8	0.2	3												
Xanthidae undetermined	10.2	3.0	205				2.0	0.4	59						
Total Decapoda	41.5	48.4	6462				2.0	0.4	59				16.7	18.4	3503
Bryozoa															
Aeverrillia setigera				4.4	0.1	180									
Amathia distans	0.8	<0.1	3												
Anguinella palmata				4.4	6.2	425									
Bugula neritina				2.2	0.1	46									
Thalamoporella gothica				6.7	2.2	531									
Total Bryozoa	0.8	<0.1	3	17.8	8.5	2105									

Table 10. (Continued)

Taxon	*Centropristis striata*			*Chaetodipterus faber*			*Archosargus probatocephalus*			*Haemulon sciurus*			*Tautoga onitis*		
Prey Item	N	V	IRI	N	V	IRI	N	V	IRI	N	V	IRI	N	V	IRI
Echinodermata															
Ophiuroidea															
Ophiothrix angulata	5.1	5.0	158												
Ophiuroidea undetermined	1.7	2.6	27												
Total Ophiuroidea	6.8	7.6	315												
Chordata															
Ascidiacea															
Aplidium sp.	0.8	5.0	18												
Ascidiacea undetermined	1.7	0.2	6												
Total Ascidiacea	2.5	5.2	48												
Pisces															
Blenniidae undetermined	1.7	3.4	32												
Hypleurochilus geminatus	2.5	20.6	217												
Teleostei undetermined	5.9	11.8	221												
Total Pisces	10.2	35.7	859												
Number of stomachs examined:		33			5			4			1			1	
Examined stomachs with food:		32			5			4			1			1	

The primary diet of sheepshead differed from both black sea bass and spadefish. Nearly 99% of the food items, by volume, were either mussels *(Brachidontes exustus)* or algae. As noted previously, the decline in subtidal mussel density on the north jetty was attributed largely to predation. The stomach content analysis supports this hypothesis since *B. exustus* represented a major component of the sheepshead's diet. Algae, which were the most prevalent taxa on the rocks during the latter part of the study, represented a major component of stomach contents from sheepshead captured in 1981 and 1982.

Stomachs from three other species were analyzed even though two of them, *Haemulon sciurus* and *Tautoga onitis*, are not generally considered to be recreationally important in South Carolina. Stomach contents from the one bluestriped grunt captured on the rock indicated that this species feeds mostly on algae, amphipods and isopods. The only tautog captured had been feeding on isopods, amphipods and decapods found on the rocks. Five southern flounder, *P. lethostigma*, were also captured for stomach content analysis but all stomachs were empty. Flounder were probably feeding at night around the Murrells Inlet jetties.

The stomach content analysis documents that the jetty fauna and flora are important food sources for the recreationally important fishes. Additionally, the results suggest that many of the fishes are minimizing competition for these food resources by concentrating on different components of the community. Similar divergence in food habits has been noted for other communities of sympatric fish species (Ross, 1977).

V. SUMMARY AND CONCLUSIONS

1. Rock jetties recently constructed at Murrells Inlet, South Carolina, provided a valuable opportunity to study colonization and community development patterns of biota on rocky substrata. Previous studies of this type have been very limited along the southeastern coast of the United States.

2. Construction began on the Murrells Inlet Navigation Project during the autumn of 1977 in order to provide a stabilized entrance channel to the ocean. The seaward terminus of the north jetty was completed by December 1978, and annual sampling was initiated at four stations on that jetty during the summer of 1979. The seaward terminus of the south jetty was completed by March 1980. Sampling began at four stations on that jetty in the spring of the same year and continued at quarterly intervals for the first year. After that, sampling was restricted to once a year during summer, as on the north jetty. The north jetty was studied over a four-year period, whereas the south jetty was studied for a three-year period. Two of the stations on each jetty were on the wave-exposed side and two others were located on the protected channel side.

3. At each station, sessile biota was assessed at 7 or 8 levels, depending on station location. Intertidal levels were located at 0.5-m intervals from mean low water (MLW) to 2.5 m above MLW; subtidal levels

were located at 1-m intervals to a maximum depth of -2.0 m. Sampling at all levels involved both line-transect and photographed-quadrat census techniques. Motile macroinvertebrates were also sampled at +1-m, MLW, -1-m, and -2-m levels at stations where water depths were sufficient to use a quantitative suction sampler. A more limited effort was made to assess fish. Sampling techniques included collections by gill nets, traps, seine net, hook and line and observations by scuba divers. Fish stomachs were also collected for diet analysis, and hydrographic samples were collected during every sampling period.

4. Water temperature, salinity, clarity, and dissolved oxygen reflected the expected hydrographic patterns in the area. Temperatures ranged from 5.8° - 30.3°C, salinity from 34.5 - 36.1 °/oo, dissolved oxygen was almost always near saturation, and water clarity varied from 0.7 to 2.5 m.

5. Results of the biological assessments indicated that a diverse assemblage of fauna and flora had colonized both jetties. At least 25 algal species, 195 macroinvertebrate species, and 34 fish species were found over the four-year study period.

6. Coverage by sessile biota was generally as great one year after construction as in subsequent years. This was primarily due to the early settling of blue-green algae and barnacles in the intertidal zone and mussels in the subtidal zone. Biota cover was generally higher in the lower intertidal and subtidal zones than in the upper intertidal zone, which represented a more rigorous physical environment. On the wave-exposed side, cover was often greater at higher levels than on the protected side. Other differences between sides were minimal, presumably because wave energy is moderate in this area. The number of sessile taxa found at the stations was as high after one year as in subsequent years. No differences were noted between sides in terms of the number of species, but more species were present subtidally than intertidally on all sides.

7. Community structure of the sessile biota showed both seasonal and yearly variation on the jetties. Variation between sampling periods was less in the intertidal zone where there was distinct banding of blue-green algae and barnacles *(Chthamalus fragilis)* in the mid- to high-intertidal area, and mussels *(Brachidontes exustus)*, barnacles *(Balanus* spp.) and algae (primarily *Ulva* sp. and *Hypnea musciformis)* in the lower region. Temporal variability in the subtidal community was much greater, with dominance changing from mussel cover *(B. exustus)* to algal, bryozoan, hydroid, and ascidian cover, depending on the side of the jetty and the year. No evidence of a stable "climax" community was found by the end of the study period, with the possible exception of the intertidal biota as noted above. Furthermore, results from other studies suggest that a "climax" community is not likely to occur. Differences observed between sampling periods, and between sides of the jetties, were attributed to predation, competition, natural mortality and light penetration (see text for details). Wave action was not considered to be an important factor with regard to differences in species composition between sides. Although species composition was different, study results paralleled findings obtained in other rocky intertidal systems.

8. Differences were noted in community structure on the south versus north jetty. These differences are partly attributed to differences in duration of rock submersion, season of rock placement at the study sites, and water depth.

9. Strong vertical gradients were detected in the distribution of most dominant sessile species. Barnacles and blue-green algae were common only in the intertidal zone. Mussels were most abundant from +0.5 m to -1 m. Green algae were abundant at MLW and shallow subtidal depths (-1 m), whereas red algae were common at those levels and at deeper depths (-2 m). Hydroids, bryozoans, and ascidians were generally restricted to subtidal areas, but in that zone less pronounced vertical gradients were observed for species in those taxa.

10. Motile macroinvertebrate species quickly colonized the rocks, with abundances as high in the first year as in subsequent years. Generally, individuals of motile species were more widely distributed among levels than noted for the sessile species, although some were limited to the intertidal or subtidal zone only. The abundance and species richness of motile fauna usually increased at the lower levels sampled, and in both zones, the dominant species were generally amphipods or isopods. Differences were noted between years with respect to overall community structure, but these differences were less than those observed for the sessile community.

11. Fishes appeared to be quickly attracted to the rocks and were present in high numbers one year after construction of the north jetty. Community composition of the fishes included many recreationally important species, such as black sea bass, sheepshead, spadefish and flounder. Analysis of fish stomach contents indicated that jetty fauna and flora were primary food items for sea bass, sheepshead, spadefish, grunt and tautog. Additionally, it appeared that these fishes minimized competition for food through differences in their primary diet component.

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APPENDIX A: PERCENT COVER OF SESSILE MACROFAUNA AND FLORA ESTIMATED FROM LINE TRANSECTS-NORTH JETTY STATIONS

Appendix A.1 Percent cover of sessile macrofauna and flora estimated from line transects (75 pts.) at station NEI. A = Ascidian, B = Barnacle, Br = Bryozoan, C = Chlorophyte, Co = Coral, E = Echinoderm, H = Hydroid, M = Mollusk, P = Polychaete, Po = Porifera, R = Rhodophyte

SPECIES	SUMMER 1979	SUMMER 1980	SUMMER 1981	SUMMER 1982	OVERALL RANK
		NEI +2.5M LEVEL			
		NO BIOTA			
		NEI +2.0M LEVEL			
Cyanophyta	37	75	81	28	1.0
Chthamalus fragilis (B)	13			1	2.0
		NEI +1.5M LEVEL			
Cyanophyta		63	84	76	1.0
Chthamalus fragilis (B)	52	8	61	16	2.0
Crassostrea virginica (M)	3				3.0
Balanus eburneus (B)	1				4.0
		NEI +1.0M LEVEL			
Chthamalus fragilis (B)	44	67	48	70	1.0
Cyanophyta		13	24		2.0
Crassostrea virginica (M)	20	1	4	4	3.0
Brachidontes exustus (M)	7		9	3	4.0
Enteromorpha sp. (C)			8		5.0
Ulva sp. (C)			5		6.5
Porphyra sp. (R)			5		6.5
Chlorophyta A			3		8.0
Balanus eburneus (B)	1		1		9.0
		NEI +0.5M LEVEL			
Brachidontes exustus (M)	69	15	84	11	1.0
Chthamalus fragilis (B)		48	1	59	2.0
Crassostrea virginica (M)	8	15	5	3	3.0
Enteromorpha sp. (C)			16		4.0
Ulva sp. (C)	3		1		5.0
Balanus eburneus (B)	1	1			6.0

SPECIES	SUMMER 1979	SUMMER 1980	SUMMER 1981	SUMMER 1982	OVERALL RANK
			NEI MLW		
Brachidontes exustus (M)	68	52	76	8	1.0
Ulva sp. (C)		61	47	1	2.0
Chthamalus fragilis (B)				56	3.0
Enteromorpha sp. (C)		16	8		4.5
Gracilaria foliifera (R)			24		4.5
Balanus eburneus (B)	9			11	6.0
Rhodophyta A			15		7.0
Polysiphonia sp. (R)		9			8.0
Crassostrea virginica (M)	3	3	1	1	9.0
Rhodophyta C			7		10.0
Balanus improvisus (B)		4			11.0
Balanus venustus (B)				3	12.0
Dynamena cornicina (H)	1		1		13.0
Molgula manhattensis (A)		1			17.0
Balanus sp. (B)			1		17.0
Bugula neritina (Br)			1		17.0
Hydroides sp. (P)		1			17.0
Cladophora sp. (C)		1			17.0
Rhodophyta B			1		17.0
Hypnea musciformis (R)		1			17.0
		NEI -1.0M LEVEL			
Gracilaria foliifera (R)		4	32	44	1.0
Brachidontes exustus (M)	13	31	4		2.0
Eudistoma carolinense (A)		3	43		3.0
Ulva sp. (C)		31	3	5	4.0
Bugula neritina (Br)	27	5		5	5.0
Obelia geniculata (H)				31	6.0
Hypnea musciformis (R)				28	7.0
Obelia dichotoma (H)	21				8.0
Cladophora sp. (C)		15		5	9.0
Polysiphonia sp. (R)	5	9	5		10.0
Anguinella palmata (Br)		8	7		11.5
Lomentaria baileyana (R)	4	11			11.5
Thalamoporella gothica (Br)			11		13.0
Plumularia floridana (H)			8		14.0
Rhodymenia pseudopalmata (R)			7		15.0
Hebella scandens (H)				5	16.5
Schizoporella errata (Br)		4	1		16.5
Crisia sp. (Br)			4		18.0
Porifera A			3		20.5
Asterias forbesii (E)	3				20.5
Sabellaria vulgaris (P)			3		20.5
Chlorophyta A			3		20.5
Mogula manhattensis (A)	1				25.5

Appendix A.1 (Continued)

SPECIES	SUMMER 1979	SUMMER 1980	SUMMER 1981	SUMMER 1982	OVERALL RANK
		NEI -1.0M LEVEL			
Microciona prolifera (Po)	1				25.5
Ostrea equestris (M)	1				25.5
Rhodophyta A			1		25.5
Callithamnion byssoides (R)				1	25.5
Cyanophyta	1				25.5

Appendix A.2 Percent cover of sessile macrofauna and flora estimated from line transects (75 pts.) at station NEO. A = Ascidian, B = Barnacle, Br = Bryozoan, C = Chlorophyte, Co = Coral, E = Echinoderm, H = Hydroid, M = Mollusk, P = Polychaete, Po = Porifera, R = Rhodophyte.

SPECIES	SUMMER 1979	SUMMER 1980	SUMMER 1981	SUMMER 1982	OVERALL RANK
		NEO +2.5M LEVEL			
Cyanophyta		1			1.0
		NEO +2.0M LEVEL			
Cyanophyta		80	73	28	1.0
Chthamalus fragilis (B)		3			2.0
		NEO +1.5M LEVEL			
Cyanophyta	75	21	100	7	1.0
Chthamalus fragilis (B)	41	4	60	29	2.0
Porphyra sp. (R)	4				3.0
		NEO +1.0M LEVEL			
Chthamalus fragilis (B)	48	81	49	80	1.0
Cyanophyta	40				2.0
Enteromorpha sp. (C)	1		24		3.0
Porphyra sp. (R)	1		8		4.0
Brachidontes exustus (M)			7		5.0
Ulva sp. (C)			5		6.0
		NEO +0.5M LEVEL			
Brachidontes exustus (M)	7	67	72	8	1.0
Chthamalus fragilis (B)		8	4	61	2.0
Ulva sp. (C)	1	3	36		3.0
Crassostrea virginica (M)	1	15	3	1	4.0
Cyanophyta	8	7			5.0
Balanus eburneus (B)		1		4	6.0

Appendix A.2 (Continued)

SPECIES	SUMMER 1979	SUMMER 1980	SUMMER 1981	SUMMER 1982	OVERALL RANK
NEO MLW					
Brachidontes exustus (M)	92	44	59		1.0
Ulva sp. (C)	1	44	31		2.0
Polysiphonia sp. (R)		48	27		3.0
Chthamalus fragilis (B)				64	4.0
Rhodophyta A			53		5.0
Cyanophyta	25				6.0
Gracilaria foliifera (R)	1		16		7.0
Balanus eburneus (B)	1	4		9	8.0
Hypnea musciformis (R)		5			9.0
Crassostrea virginica (M)			3		11.0
Chlorophyta A			3		11.0
Rhodymenia pseudopalmata (R)			3		11.0
Cladophora sp. (C)	1	1			13.0
Enteromorpha sp. (C)		1			14.5
Porphyra sp. (R)			1		14.5
NEO -1.0M LEVEL					
Brachidontes exustus (M)	79	2	9		1.0
Rhodymenia pseudopalmata (R)		20	23	36	2.0
Gracilaria foliifera (R)	1	11	51	15	3.0
Obelia dichotoma (H)	4	1	40		4.0
Hypnea musciformis (R)				37	5.0
Sertularia marginata (H)				25	6.0
Polysiphonia sp. (R)	1	4	19		7.0
Bugula neritina (Br)		19	3		8.0
Eudistoma carolinense (A)			17		9.0
Ulva sp. (C)		8	5		10.0
Chlorophyta A			12		11.0
Enteromorpha sp. (C)	3	7			12.5
Lomentaria baileyana (R)	3	7			12.5
Obelia geniculata (H)				9	15.0
Dynamena cornicina (H)	1		3	5	15.0
Bryopsis plumosa (C)				9	15.0
Schizoporella errata (Br)		5	3		17.0
Crisia sp. (Br)			7		18.5
Hydroides sp. (P)		4		3	18.5
Perophora viridis (A)			1	3	21.5
Distaplia bermudensis (A)		4			21.5
Menbranipora tenuis (Br)		4			21.5
Rhodophyta A			4		21.5
Balanus niveus (B)		3			25.5
Balanus venustus (B)			3		25.5
Dynamena quadridentata (H)				3	25.5

Appendix A.2 (Continued)

SPECIES	SUMMER 1979	SUMMER 1980	SUMMER 1981	SUMMER 1982	OVERALL RANK
		NEO -1.0M LEVEL			
Sertularia distans (H)				3	25.5
Balanus improvisus (B)	1		1		28.5
Astrangia astreiformis (Co)		1	1		28.5
Styela plicata (A)	1				31.5
Asterias forbesii (E)	1				31.5
Ostrea equestris (M)			1		31.5
Callithamnion byssoides (R)				1	31.5
		NEO -2.0M LEVEL			
Rhodymenia pseudopalmata (R)		35	32	67	1.0
Brachidontes exustus (M)	47				2.0
Distaplia bermudensis (A)		1	40	4	3.0
Bugula neritina (Br)	5	21	17		4.0
Schizoporella errata (Br)		28	5		5.0
Gracilaria foliifera (R)		4	8	12	6.0
Perophora viridis (A)	7		11	4	7.0
Sertularia distans (H)				19	8.0
Crisia sp. (Br)			13	1	9.0
Obelia dichotoma (H)	12		1		10.0
Obelia geniculata (H)				12	11.0
Ulva sp. (C)		8			12.0
Eudistoma carolinense (A)			3	4	14.5
Halocordyle disticha (H)		7			14.5
Dynamena quadridentata (H)			3	4	14.5
Hydroides sp. (P)		4		3	14.5
Asterias forbesii (E)	5				17.0
Dynamena cornicina (H)	3	1			19.5
Anguinella palmata (Br)		1	3		19.5
Ostrea equestris (M)		1	3		19.5
Hypnea musciformis (R)				4	19.5
Thalamoporella gothica (Br)				3	23.0
Mytilidae (M)	3				23.0
Polysiphonia sp. (R)			3		23.0
Bougainvillia rugosa (H)	1				27.0
Codium sp. (C)		1			27.0
Blidingia minima (C)	1				27.0
Lomentaria baileyana (R)		1			27.0
Corallinaceae (R)				1	27.0

Appendix A.3 Percent cover of sessile macrofauna and flora estimated from line transects (75 pts.) at station NPI. A = Ascidian, B = Barnacle, Br = Bryozoan, C = Chlorophyte, Co = Coral, E = Echinoderm, H = Hydroid, M = Mollusk, P = Polychaete, Po = Porifera, R = Rhodophyte.

SPECIES	SUMMER 1979	SUMMER 1980	SUMMER 1981	SUMMER 1982	OVERALL RANK
		NPI +2.5M LEVEL			
		NO BIOTA			
		NPI +2.0M LEVEL			
Cyanophyta		13	83	3	1.0
Chthamalus fragilis (B)	35	1			2.0
		NPI +1.5M LEVEL			
Cyanophyta		16	99	87	1.0
Chthamalus fragilis (B)	45	7	20	16	2.0
Crassostrea virginica (M)	1				3.0
		NPI +1.0M LEVEL			
Chthamalus fragilis (B)	45	59	57	52	1.0
Cyanophyta	47	7	49	9	2.0
Crassostrea virginica (M)	11	3	11	3	3.0
Porphyra sp. (R)			20	1	4.0
Chlorophyta A			20		5.0
Brachidontes exustus (M)	3				6.0
		NPI +0.5M LEVEL			
Brachidontes exustus (M)	71	19	29	4	1.0
Chthamalus fragilis (B)	1	37	4	28	2.0
Crassostrea virginica (M)	3	24	16	17	3.0
Cyanophyta			33	13	4.0
Enteromorpha sp. (C)			36		5.0
Ulva sp. (C)			8		6.0
		NPI MLW			
Brachidontes exustus (M)	53	33	83	8	1.0
Ulva sp. (C)		15	53	35	2.0
Polysiphonia sp. (R)		40	4		3.0
Hypnea musciformis (R)	4			16	4.0
Cyanophyta		1		13	5.0

Appendix A.3 (Continued)

SPECIES	SUMMER 1979	SUMMER 1980	SUMMER 1981	SUMMER 1982	OVERALL RANK
		NPI MLW			
Bryopsis plumosa (C)				12	6.5
Rhodophyta B			12		6.5
Herposiphonia tenella secunda (R)	11				8.0
Cladophora sp. (C)	5	4			9.5
Lomentaria baileyana (R)	9				9.5
Enteromorpha sp. (C)		7			11.0
Crassostrea virginica (M)	1	1		3	12.0
Gracilaria foliifera (R)		3	1		13.0
Balanus improvisus (B)				3	14.0
Molgula manhattensis (A)		1			16.5
Balanus eburneus (B)	1				16.5
Balanus sp. (B)				1	16.5
Rhodophyta A			1		16.5
		NPI -1.0M LEVEL			
Eudistoma carolinense (A)		36	47	49	1.0
Gracilaria foliifera (R)	4	15	33	24	2.0
Brachidontes exustus (M)	11	16	3		3.0
Polysiphonia sp. (R)	21	1	4		4.0
Obelia dichotoma (H)	13		5	4	5.0
Hypnea musciformis (R)				21	6.0
Distaplia bermudensis (A)			4	4	7.0
Molgula manhattensis (A)	4		3		9.0
Porifera A			7		9.0
Bryopsis pennata (C)	7				9.0
Ulva sp. (C)		5		1	11.0
Trididemnum savignii (A)		5			12.5
Bugula neritina (Br)		1	4		12.5
Dynamena cornicina (H)	3			1	15.0
Schizoporella errata (Br)		4			15.0
Rhodymenia pseudopalmata (R)			1	3	15.0
Eudistoma hepaticum (A)				3	18.5
Actiniaria		3			18.5
Cladophora sp. (C)		3			18.5
Antithamnion cruciatum (R)				3	18.5
Plumularia floridana (H)	1				22.5
Actiniaria A			1		22.5
Crisia sp. (Br)				1	22.5
Hydroides sp. (P)	1				22.5

Appendix A.4 Percent cover of sessile macrofauna and flora estimated from line transects (75 pts.) at station NPO. A = Ascidian, B = Barnacle, Br = Bryozoan, C = Chlorophyte, Co = Coral, E = Echinoderm, H = Hydroid, M = Mollusk, P = Polychaete, Po = Porifera, R = Rhodophyte.

SPECIES	SUMMER 1979	SUMMER 1980	SUMMER 1981	SUMMER 1982	OVERALL RANK
NPO +2.5M LEVEL					
NO BIOTA					
NPO +2.0M LEVEL					
Cyanophyta	12	24	11	3	1.0
NPO +1.5M LEVEL					
Cyanophyta	23		87	80	1.0
Chthamalus fragilis (B)	24	3	19	21	2.0
Chlorophyta A			12		3.0
Porphyra sp. (R)			5		4.0
NPO +1.0M LEVEL					
Chthamalus fragilis (B)	55	76	49	53	1.0
Cyanophyta		4	75	21	2.0
Enteromorpha sp. (C)			57		3.0
Ulva sp. (C)			13		4.0
Brachidontes exustus (M)		3	9		5.0
Crassostrea virginica (M)		1	4		6.0
Porphyra sp. (R)			4		7.0
NPO +0.5M LEVEL					
Brachidontes exustus (M)	44	24	89	1	1.0
Chthamalus fragilis (B)		52	1	44	2.0
Ulva sp. (C)			39		3.0
Cyanophyta				23	4.0
Crassostrea virginica (M)		9		3	5.0
Enteromorpha sp. (C)			7		6.0
Balanus eburneus (B)	3				7.0

Appendix A.4 (Continued)

SPECIES	SUMMER 1979	SUMMER 1980	SUMMER 1981	SUMMER 1982	OVERALL RANK
			NPO MLW		
Brachidontes exustus (M)		80	51	5	1.0
Hypnea musciformis (R)	79			16	2.0
Ulva sp. (C)	1	11	13	33	3.0
Polysiphonia sp. (R)		19	5		4.0
Gracilaria foliifera (R)	4		13		5.0
Rhodophyta C			16		6.5
Cyanophyta				16	6.5
Chlorophyta B			11		8.0
Enteromorpha sp. (C)		1	9		9.0
Rhodophyta B			7		10.0
Crassostrea virginica (M)		3		3	11.0
Lomentaria baileyana (R)	5				12.0
Chlorophyta A			4		13.0
Balanus improvisus (B)		3			14.5
Cladophora sp. (C)		3			14.5
Perophora viridis (A)	1				17.0
Chthamalus fragilis (B)				1	17.0
Modiolus sp. (M)	1				17.0
			NPO -1.0M LEVEL		
Brachidontes exustus (M)	52		11		1.5
Gracilaria foliifera (R)		4	4	55	1.5
Lomentaria baileyana (R)	16	15			3.0
Perophora viridis (A)	21		3		4.5
Polysiphonia sp. (R)	5	19			4.5
Hypnea musciformis (R)				20	6.0
Bryopsis plumosa (C)				17	7.0
Eudistoma carolinense (A)			16		8.5
Cladophora sp. (C)		16			8.5
Halocordyle disticha (H)		12	3		10.0
Thalamoporella gothica (Br)			10		11.0
Distaplia bermudensis (A)		7	1		13.0
Dynamena cornicina (H)	1	4	3		13.0
Ulva sp. (C)		1		7	13.0
Clavelina picta (A)		6			15.0
Aplidium sp. (A)	5				17.0
Schizoporella errata (Br)		5			17.0
Rhodymenia pseudopalmata (R)			4	1	17.0

Appendix A.4 (Continued)

SPECIES	SUMMER 1979	SUMMER 1980	SUMMER 1981	SUMMER 1982	OVERALL RANK
NPO -1.0M LEVEL					
Plumularia floridana (H)			4		20.5
Parasmittina nitida (Br)		1	3		20.5
Chlorophyta A			4		20.5
Gelidium crinale (R)				4	20.5
Balanus improvisus (B)		3			24.5
Leptogorgia virgulata (Co)			3		24.5
Obelia geniculata (H)				3	24.5
Undetermined biota		3			24.5
Balanus venustus (B)			1	1	28.0
Eudendrium carneum (H)		1	1		28.0
Hydroides sp. (P)		1		1	28.0
Eudistoma hepaticum (A)			1		34.0
Balanus niveus (B)		1			34.0
Obelia dichotoma (H)	1				34.0
Sertularia distans (H)				1	34.0
Schizotricha tenella (H)	1				34.0
Asterias forbesii (E)	1				34.0
Bugula neritina (Br)		1			34.0
Crisia sp. (Br)				1	34.0
Rhodophyta B			1		34.0
NPO -2.0M LEVEL					
Obelia dichotoma (H)	23	84	1	13	1.0
Eudistoma carolinense (A)			56	31	2.0
Brachidontes exustus (M)	24		7		3.0
Perophora viridis (A)	27		1		4.0
Obelia geniculata (H)			17	5	5.0
Distaplia bermudensis (A)		3		16	6.0
Aplidium sp. (A)	16				7.0
Halocordyle disticha (H)			5	9	8.5
Cladophora sp. (C)				14	8.5
Dynamena cornicina (H)	5		1	7	10.0
Sabellaria vulgaris (P)		11			11.5
Rhodymenia pseudopalmata (R)			4	7	11.5
Gracilaria foliifera (R)			1	8	13.0
Schizoporella errata (Br)		5	1		14.0
Clavelina picta (A)	4		1		15.0
Molgula manhattensis (A)	3	1			16.5
Eudistoma hepaticum (A)				4	16.5
Asterias forbesii (E)	3				18.0
Astrangia astreiformis (Co)		1	1		19.0
Porifera	1				23.0
Haliclona sp. A (Po)		1			23.0
Haliclona sp. B (Po)		1			23.0
Leptogorgia virgulata (Co)			1		23.0
Eudendrium carneum (H)		1			23.0
Schizotricha tenella (H)	1				23.0

APPENDIX B: PERCENT COVER OF SESSILE MACROFAUNA AND FLORA ESTIMATED FROM PHOTOGRAPHIC QUADRATS- NORTH JETTY STATIONS

Appendix B.1 Percent cover of sessile macrofauna and flora estimated from photographic quadrats (100 cm^2) at station NEI. A = Ascidian, B = Barnacle, Br = Bryozoan, C = Chlorophyte, Co = Coral, E = Echinoderm, H = Hydroid, M = Mollusk, P = Polychaete, Po = Porifera, R = Rhodophyte.

SPECIES	SUMMER 1979	SUMMER 1980	SUMMER 1981	SUMMER 1982	OVERALL RANK
NEI +2.5M LEVEL					
NO BIOTA					
NEI +2.0M LEVEL					
Chthamalus fragilis (B)	1			1	1.0
NEI +1.5M LEVEL					
Chthamalus fragilis (B)	52	4	56	9	1.0
NEI +1.0M LEVEL					
Chthamalus fragilis (B)	22	57	40	46	1.0
Crassostrea virginica (M)	13	2	4		2.0
Brachidontes exustus (M)	5		8	5	3.0
Ulva sp. (C)			5		4.0
Cladophora sp. (C)			3		5.5
Porphyra sp. (R)			3		5.5
NEI +0.5M LEVEL					
Brachidontes exustus (M)	57	9	87	7	1.0
Chthamalus fragilis (B)		52	1	44	2.0
Crassostrea virginica (M)	2	17	3	6	3.0
Ulva sp. (C)	1		16		4.0
Gracilaria foliifera (R)	12		1		5.0
Balanus eburneus (B)	6				6.0
Hydroides sp. (P)		1			8.0
Chlorophyta			1		8.0
Enteromorpha sp. (C)			1		8.0

Appendix B.1 (Continued)

SPECIES	SUMMER 1979	SUMMER 1980	SUMMER 1981	SUMMER 1982	OVERALL RANK
		NEI MLW			
Ulva sp. (C)	19	67	32	3	1.0
Brachidontes exustus (M)	40	18	41	10	2.0
Chthamalus fragilis (B)				28	3.0
Gracilaria foliifera (R)	3		18		4.0
Rhodophyta	12		1		5.5
Hypnea musciformis (R)			13		5.5
Balanomorpha (B)				6	7.5
Crassostrea virginica (M)		2		4	7.5
Balanus eburneus (B)				3	9.5
Algae			3		9.5
Balanus sp. (B)	2				12.0
Halocordyle disticha (H)	2				12.0
Enteromorpha sp. (C)			2		12.0
Hydroides sp. (P)				1	15.5
Chlorophyta A		1			15.5
Rhodophyta A		1			15.5
Undetermined biota	1				15.5
		NEI -1.0M LEVEL			
Undetermined biota	9	12	31	12	1.0
Gracilaria foliifera (R)	10	10	8	22	2.0
Halocordyle disticha (H)	37	4			3.0
Ulva sp. (C)		8	13	11	4.5
Rhodymenia pseudopalmata (R)			6	26	4.5
Bugula neritina (Br)		21			6.0
Asterias forbesii (E)	15				7.5
Hypnea musciformis (R)		6		9	7.5
Ascidiacea A			14		9.0
Algae	11			2	10.0
Rhodophyta		9		3	11.0
Eudistoma carolinense (A)			9		12.5
Brachidontes exustus (B)		8	1		12.5
Chlorophyta		6	1		14.0
Hydroidea			5	1	15.5
Arbacia punctulata (E)				6	15.5
Anguinella palmata (Br)		5			17.0
Eudistoma hepaticum (A)			3		19.5
Eudendrium carneum (H)				3	19.5
Obelia sp. (H)				3	19.5
Cladophora sp. (C)		3			19.5
Hydroides sp. (P)	2				22.0
Styela plicata (A)			1		24.0
Schizoporella cornuta (Br)		1			24.0
Rhodophyta A			1		24.0

Appendix B.2 Percent cover of sessile macrofauna and flora estimated from photographic quadrats (100 cm^2) at station NEO. A = Ascidian, B = Barnacle, Br = Bryozoan, C = Chlorophyte, Co = Coral, E = Echinoderm, H = Hydroid, M = Mollusk, P = Polychaete, Po = Porifera, R = Rhodophyte.

SPECIES	SUMMER 1979	SUMMER 1980	SUMMER 1981	SUMMER 1982	OVERALL RANK
		NEO +2.5M LEVEL			
		NO BIOTA			
		NEO +2.0M LEVEL			
Chthamalus fragilis (B)	16	2			1.0
Rhodophyta	16				2.0
Porphyra sp. (R)	5				3.0
		NEO +1.5M LEVEL			
Chthamalus fragilis (B)	16	6	52	48	1.0
Ulva sp. (C)	25				2.0
Chlorophyta	10				3.0
Porphyra sp. (R)	4				4.0
Rhodophyta	2				5.0
		NEO +1.0M LEVEL			
Chthamalus fragilis (B)	16	68	44	63	1.0
Enteromorpha sp. (C)	16		17		2.0
Ulva sp. (C)	27				3.0
Undetermined biota	14		8		4.0
Brachidontes exustus (M)	1	3	1	1	5.0
Chlorophyta	3		1		6.0
Crassostrea virginica (M)		2	1		7.0
Porphyra sp. (R)			1		8.0
		NEO +0.5M LEVEL			
Brachidontes exustus (M)	72	55	24	6	1.0
Ulva sp. (C)			54		2.0
Chthamalus fragilis (B)	1	10	1	40	3.0
Crassostrea virginica (M)	1	14	5	1	4.0
Chlorophyta	5		1		5.0
Balanus eburneus (B)	4				6.0
Undetermined biota			1		7.0

Appendix B.2 (Continued)

SPECIES	SUMMER 1979	SUMMER 1980	SUMMER 1981	SUMMER 1982	OVERALL RANK
		NEO MLW			
Brachidontes exustus (M)	79	17	N	1	1.0
Ulva sp. (C)	1	56	O		2.0
Chthamalus fragilis (B)		2		49	3.0
Rhodophyta		23	D		4.0
Chlorophyta	8		A		5.0
Undetermined biota	7		T		6.0
Balanus eburneus (B)			A	4	7.0
Balanus sp. (B)	2				8.0
Balanomorpha (B)				1	9.5
Hydroides sp. (P)				1	9.5
		NEO -1.0M LEVEL			
Rhodymenia pseudopalmata (R)		26	52	32	1.0
Brachidontes exustus (M)	79	1			2.0
Undetermined biota	15	13	10	3	3.0
Hypnea musciformis (R)				27	4.0
Schizoporella cornuta (Br)		26			5.0
Ulva sp. (C)		15	5	1	6.0
Gracilaria foliifera (R)		1	3	14	7.0
Algae	6		2	9	8.0
Rhodophyta A			10		9.0
Hydroides sp. (P)		7	1		10.0
Cladophora sp. (C)			3	4	11.5
Polysiphonia sp. (R)		7			11.5
Hydroidea				6	13.0
Obelia sp. (H)				5	14.0
Rhodophyta				4	15.0
Ascidiacea		3			16.0
Dynamena cornicina (H)		2			17.0
Balanus sp. (B)				1	19.5
Obelia geniculata (H)		1			19.5
Asterias forbesii (E)	1				19.5
Chlorophyta				1	19.5

Appendix B.2 (Continued)

SPECIES	SUMMER 1979	SUMMER 1980	SUMMER 1981	SUMMER 1982	OVERALL RANK
NEO -2.0M LEVEL					
Rhodymenia pseudopalmata (R)	1	2	40	59	1.0
Undetermined biota	49	23	18	6	2.0
Anguinella palmata (Br)		37			3.0
Brachidontes exustus (M)	23				4.0
Asterias forbesii (E)	20				5.0
Gracilaria foliifera (R)		3	3	13	6.0
Ascidiacea A			12		7.0
Schizoporella cornuta (Br)		11			8.0
Distaplia bermudensis (A)			8		9.0
Crisia sp. (Br)			7		10.0
Algae	5			1	11.0
Leptogorgia virgulata (Co)	1	4			13.0
Hydroidea				5	13.0
Hydroides sp. (P)	1	3	1		13.0
Dynamena cornicina (H)			4		15.0
Perophora viridis (A)			3		16.5
Ascidiacea B			3		16.5
Arbacia punctulata (E)				2	19.5
Bugula neritina (Br)		2			19.5
Ulva sp. (C)		2			19.5
Rhodophyta				2	19.5
Sertularia marginata (H)				1	23.0
Astrangia astreiformis (Co)		1			23.0
Schizoporella errata (Br)	1				23.0

Appendix B.3 Percent cover of sessile macrofauna and flora estimated from photographic quadrats (100 cm^2) at station NPI. A = Ascidian, B = Barnacle, Br = Bryozoan, C = Chlorophyte, Co = Coral, E = Echinoderm, H = Hydroid, M = Mollusk, P = Polychaete, Po = Porifera, R = Rhodophyte.

SPECIES	SUMMER 1979	SUMMER 1980	SUMMER 1981	SUMMER 1982	OVERALL RANK
		NPI +2.5M LEVEL			
		NO BIOTA			
		NPI +2.0M LEVEL			
Chthamalus fragilis (B)	13				1.0
		NPI +1.5M LEVEL			
Chthamalus fragilis (B)	40	8	35	15	1.0
		NPI +1.0M LEVEL			
Chthamalus fragilis (B)	40	47	37	52	1.0
Crassostrea virginica (M)	18	5	3		2.0
Enteromorpha sp. (C)			17		3.0
Porphyra sp. (R)	2		11	1	4.0
Brachidontes exustus (M)	2		1		5.0
Balanus eburneus (B)	1				7.0
Hydroides sp. (P)	1				7.0
Chlorophyta			1		7.0
		NPI +0.5M LEVEL			
Chthamalus fragilis (B)		37	1	23	1.0
Brachidontes exustus (M)	25	6	18	5	2.0
Ulva sp. (C)			46		3.0
Crassostrea virginica (M)	4	11	10	17	4.0
Cladophora sp. (C)			18		5.0
Balanus eburneus (B)	9				6.0
Enteromorpha sp. (C)	3		1		7.5
Rhodophyta	4				7.5
Balanomorpha (B)			2		9.0

Appendix B.3 (Continued)

SPECIES	SUMMER 1979	SUMMER 1980	SUMMER 1981	SUMMER 1982	OVERALL RANK
NPI MLW					
Ulva sp. (C)	4	11	59	30	1.0
Brachidontes exustus (M)	9	26	39	2	2.0
Rhodophyta	72				3.0
Rhodophyta A		29			4.0
Hypnea musciformis (R)				10	5.0
Gracilaria foliifera (R)	3		5		6.0
Bryopsis plumosa (C)				5	7.0
Hydroides sp. (P)	1		1	1	8.5
Chlorophyta B		3			8.5
Balanus sp. (B)	1			1	11.0
Crassostrea virginica (M)				2	11.0
Chlorophyta	1			1	11.0
Balanomorpha (B)				1	13.5
Enteromorpha sp. (C)	1				13.5
NPI -1.0M LEVEL					
Brachidontes exustus (M)	58				1.0
Gracilaria foliifera (R)		16	26	11	2.0
Eudistoma carolinense (A)		22	7	13	3.5
Undetermined biota			22	19	3.5
Hydroidea A		36			5.0
Ascidiacea		25		7	6.0
Eudistoma hepaticum (A)			18		7.0
Algae	11			1	8.0
Hypnea musciformis (R)				11	9.0
Distaplia bermudensis (A)	9				10.0
Rhodophyta				7	11.0
Chlorophyta			2	4	12.0
Clavelina picta (A)	5				13.0
Hydroidea		1		3	14.5
Cladophora sp. (C)		4			14.5
Aplidium constellatum (A)			3		17.0
Perophora viridis (A)	3				17.0
Leptogorgia virgulata (Co)	1	2			17.0
Sertularia sp. (H)		2			19.5
Codium decorticatum (C)				2	19.5
Halocordyle disticha (H)	1				21.5
Ulva sp. (C)				1	21.5

Appendix B.4 Percent cover of sessile macrofauna and flora estimated from photographic quadrats (100 cm^2) at station NPO. A = Ascidian, B = Barnacle, Br = Bryozoan, C = Chlorophyte, Co = Coral, E = Echinoderm, H = Hydroid, M = Mollusk, P = Polychaete, Po = Porifera, R = Rhodophyte.

SPECIES	SUMMER 1979	SUMMER 1980	SUMMER 1981	SUMMER 1982	OVERALL RANK
		NPO +2.5M LEVEL			
		NO BIOTA			
		NPO +2.0M LEVEL			
Rhodophyta	37				1.0
Porphyra sp. (R)	2				2.0
Chthamalus fragilis (B)	1				3.0
		NPO +1.5M LEVEL			
Chthamalus fragilis (B)	51	4	14	4	1.0
Ulva sp. (C)			15		2.0
Porphyra sp. (R)			4		3.0
Enteromorpha sp. (C)			1		4.0
		NPO +1.0M LEVEL			
Chthamalus fragilis (B)	31	66	13	49	1.0
Ulva sp. (C)			31		2.0
Brachidontes exustus (M)	20	2	1		3.0
Enteromorpha sp. (C)			16		4.0
Chlorophyta			10		5.0
Crassostrea virginica (M)	1				7.5
Porphyra sp. (R)			1		7.5
Rhodophyta A		1			7.5
Undetermined biota			1		7.5
		NPO +0.5M LEVEL			
Brachidontes exustus (M)	56	65	58	1	1.0
Ulva sp. (C)			43		2.0
Chthamalus fragilis (B)	1	8		30	3.0
Crassostrea virginica (M)	1	6		3	4.0
Undetermined biota	5				5.0
Chlorophyta A		2			6.0
Balanomorpha (B)			1		7.5
Rhodophyta A		1			7.5

Appendix B.4 (Continued)

SPECIES	SUMMER 1979	SUMMER 1980	SUMMER 1981	SUMMER 1982	OVERALL RANK
			NPO MLW		
Brachidontes exustus (B)	30	38	N	1	1.0
Ulva sp. (C)		11		29	2.0
Rhodophyta A		12	O		3.0
Chlorophyta	8			1	4.0
Undetermined biota	8				5.0
Hypnea musciformis (R)			D	7	6.0
Balanomorpha (B)		2		2	7.0
Crassostrea virginica (M)	1		A	2	8.0
Balanus sp. (B)	1				10.0
Chlorophyta B		1	T		10.0
Rhodophyta	1		A		10.0
			NPO -1.0M LEVEL		
Brachidontes exustus (B)	60		4	2	1.0
Undetermined biota	24	14	7	14	2.0
Gracilaria foliifera (R)	1	11	28	17	3.0
Rhodymenia pseudopalmata (R)			22	27	4.0
Hypnea musciformis (R)				25	5.0
Eudistoma carolinense (A)			14		6.0
Cladophora sp. (C)		7	1		7.0
Polysiphonia sp. (R)		7			8.0
Perophora viridis (A)	6				9.5
Chlorophyta				6	9.5
Obelia geniculata (H)			5		11.0
Eudistoma hepaticum (A)			4		13.0
Cliona sp. (Po)		4			13.0
Asterias forbesii (E)	4				13.0
Aplidium constellatum (A)			2		17.5
Hydroidea		2			17.5
Astrangia astreiformis (Co)		2			17.5
Schizoporella errata (Br)	1	1			17.5
Algae	2				17.5
Rhodophyta				2	17.5
Leptogorgia virgulata (Co)		1			21.5
Hydroides sp. (P)	1				21.5

Appendix B.4 (Continued)

SPECIES	SUMMER 1979	SUMMER 1980	SUMMER 1981	SUMMER 1982	OVERALL RANK
		NPO -2.0M LEVEL			
Undetermined biota	64	4	11	39	1.0
Obelia dichotoma (H)		48			2.0
Eudistoma carolinense (A)			23		3.0
Gracilaria foliifera (R)			14	3	4.0
Eudistoma hepaticum (A)		7	8	1	5.0
Distaplia bermudensis (A)		5	9	1	6.0
Leptogorgia virgulata (Co)		1	11	1	7.5
Chlorophyta				13	7.5
Clavelina picta (A)	2	10			9.0
Bryozoa				11	10.0
Hydroidea			1	7	11.5
Brachidontes exustus (M)	8				11.5
Perophora viridis (A)	7				14.0
Ascidiacea				7	14.0
Halocordyle disticha (H)		7			14.0
Obelia geniculata (H)			4		16.5
Schizoporella cornuta (Br)		4			16.5
Asterias forbesii (E)	2				18.0
Molgula sp. (A)	1				22.0
Plumularia floridana (H)			1		22.0
Actiniaria			1		22.0
Astrangia astreiformis (Co)			1		22.0
Hydroides sp. (P)		1			22.0
Rhodophyta				1	22.0
Rhodymenia pseudopalmata (R)				1	22.0

APPENDIX C: PERCENT COVER OF SESSILE MACROFAUNA AND FLORA ESTIMATED FROM LINE TRANSECTS-SOUTH JETTY STATIONS

Appendix C.1 Percent cover of sessile macrofauna and flora estimated from line transects (75 pts.) at station SEI. A = Ascidian, B = Barnacle, Br = Bryozoan, C = Chlorophyte, Co = Coral, D = Diatom, E = Echinoderm, H = Hydroid, M = Mollusk, P = Polychaete, Ph = Phaeophyte, Po = Porifera, R = Rhodophyte

SPECIES	SPRING 1980	SUMMER 1980	FALL 1980	WINTER 1981	SUMMER 1981	SUMMER 1982	OVERALL RANK
			SEI +2.5M LEVEL				
			NO BIOTA				
			SEI +2.0M LEVEL				
Cyanophyta			35	8	4		1.0
Chthamalus fragilis (B)		1	4			4	2.0
			SEI +1.5M LEVEL				
Chthamalus fragilis (B)	4	69	75	63	45	32	1.0
Cyanophyta		75	20	17	17		2.0
Porphyra sp. (R)	15						3.0
Crasscstrea virginica (M)						3	4.5
Polysiphonia sp. (R)	3						4.5
Brachidontes exustus (M)					1		6.0
			SEI +1.0M LEVEL				
Chthamalus fragilis (B)	39	96	68	60	N	15	1.0
Porphyra sp. (R)	65				O		2.0
Crassostrea virginica (M)			13	7		3	3.0
Cyanophyta		20			D		4.0
Enteromorpha sp. (C)	11				A		5.0
Brachidontes exustus (M)			8		T	1	6.0
Balanus venustus (B)					A	1	7.0
			SEI +0.5M LEVEL				
Chthamalus fragilis (B)	19	56	37	21	N	N	1.0
Crassostrea virginica (M)			53	69	O	O	2.0
Porphyra sp. (R)	85						3.0
Cyanophyta		75			D	D	4.0
Brachidontes exustus (M)		1	16	16	A	A	5.0
Balanus eburneus (B)		1		1	T	T	6.0
					A	A	

Appendix C.1 (Continued)

SPECIES	SPRING 1980	SUMMER 1980	FALL 1980	WINTER 1981	SUMMER 1981	SUMMER 1982	OVERALL RANK
SEI MLW							
Brachidontes exustus (M)		1	84	69	N	N	1.0
Enteromorpha sp. (C)	49	13	8				2.0
Cyanophyta	20	11			O	O	3.0
Balanus eburneus (B)		13		3			4.0
Balanus improvisus (B)	5						5.5
Bugula neritina (Br)	5				D	D	5.5
Polysiphonia sp. (R)	3						7.5
Hypnea musciformis (R)		3			A	A	7.5
Balanus niveus (B)			1				9.5
Urosalpinx sp. (M)				1	T	T	9.5
					A	A	

Appendix C.2 Percent cover of sessile macrofauna and flora estimated from line transects (75 pts.) at station SEO. A = Ascidian, B = Barnacle, Br = Bryozoan, C = Chlorophyte, Co = Coral, D = Diatom, E = Echinoderm, H = Hydroid, M = Mollusk, P = Polychaete, Ph = Phaeophyte, Po = Porifera, R = Rhodophyte

SPECIES	SPRING 1980	SUMMER 1980	FALL 1980	WINTER 1981	SUMMER 1981	SUMMER 1982	OVERALL RANK
SEO +2.5M LEVEL							
Erythrotrichia carnea (R)		20					1.5
Cyanophyta		20					1.5
Enteromorpha sp. (C)		3					3.0
SEO +2.0M LEVEL							
Cyanophyta		48	79	51	45		1.0
Enteromorpha sp. (C)		9					2.0
Erythrotrichia carnea (R)		3					3.0
Chthamalus fragilis (B)		1				1	4.0
SEO +1.5M LEVEL							
Chthamalus fragilis (B)		92	29	83	74	25	1.0
Cyanophyta		55	4	49	33	3	2.0
Crassostrea virginica (M)		3					3.0
SEO +1.0M LEVEL							
Chthamalus fragilis (B)		35	72	85	45	28	1.0
Brachidontes exustus (M)		24	11	5	11		2.0
Cyanophyta			11	12	25		3.0
Crassostrea virginica (M)		7	9	3	4	1	4.0
Enteromorpha sp. (C)		16		1			5.0
Erythrotrichia carnea (R)	12						6.0
Porphyra sp. (R)					9		7.0
Balanus eburneus (B)		1					8.0
SEO +0.5M LEVEL							
Brachidontes exustus (M)		76	90	80	75	15	1.0
Cyanophyta		5	4	5	16	13	2.0
Enteromorpha sp. (C)	1	19		7			3.0
Chthamalus fragilis (B)		1				19	4.0
Crassostrea virginica (M)			8			5	5.0
Balanus improvisus (B)	9						6.0
Ulva sp. (C)		3	1				7.0
Balanus niveus (B)			1				10.0
Hydroides sp. (P)		1					10.0
Cladophora sp. (C)		1					10.0
Polysiphonia sp. (R)		1					10.0
Gracilaria foliifera (R)		1					10.0

Appendix C.2 (Continued)

SPECIES	SPRING 1980	SUMMER 1980	FALL 1980	WINTER 1981	SUMMER 1981	SUMMER 1982	OVERALL RANK
			SEO MLW				
Brachidontes exustus (M)		92	96	87	44	8	1.0
Ulva sp. (C)		16	31	1	4	55	2.0
Bryopsis plumosa (C)				11			3.0
Balanus improvisus (B)	9						5.0
Hypnea musciformis (R)		5				4	5.0
Cyanophyta		9					5.0
Enteromorpha sp. (C)	5	1		1			7.0
Balanus eburneus (B)		1		1	3		8.5
Polysiphonia sp. (R)		5					8.5
Hydroides sp. (P)					1	3	10.0
Cladophora sp. (C)				3			11.0
Gracilaria foliifera (R)		1		1			12.0
Crassostrea virginica (M)						1	14.5
Chlorophyta A					1		14.5
Giffordia mitchellae (Ph)				1			14.5
Rhodophyta A					1		14.5

Appendix C.3 Percent cover of sessile macrofauna and flora estimated from line transects (75 pts.) at station SPI. A = Ascidian, B = Barnacle, Br = Bryozoan, C = Chlorophyte, Co = Coral, D = Diatom, E = Echinoderm, H = Hydroid, M = Mollusk, P = Polychaete, Ph = Phaeophyte, Po = Porifera, R = Rhodophyte

SPECIES	SPRING 1980	SUMMER 1980	FALL 1980	WINTER 1981	SUMMER 1981	SUMMER 1982	OVERALL RANK
SPI +2.5M LEVEL							
NO BIOTA							
SPI +2.0M LEVEL							
NO BIOTA							
SPI +1.5M LEVEL							
Cyanophyta		45	24		8	13	1.0
Chthamalus fragilis (B)	1		3			20	2.0
Enteromorpha sp. (C)	7						3.0
SPI +1.0M LEVEL							
Chthamalus fragilis (B)	8	12	36	61	52	9	1.0
Cyanophyta		28	28	23			2.0
Porphyra sp. (R)	61						3.0
Crassostrea virginica (M)				1		26	4.0
Ulothrix flacca (C)				11			5.0
Brachidontes exustus (M)						3	6.5
Enteromorpha sp. (C)	3						6.5
Monostroma osyspermum (C)	1						8.5
Bangia atropurpurea (R)	1						8.5
SPI +0.5M LEVEL							
Cyanophyta			73	80	8	N	1.0
Cladophora sp. (C)		79				O	2.0
Chthamalus fragilis (B)	5	8	9	8	31		3.0
Enteromorpha sp. (C)	51			7			4.0
Crassostrea virginica (M)		8	8	8	23	D	5.0
Porphyra sp. (R)	33			1		A	6.0
Brachidontes exustus (B)		3	5	1	20	T	7.0
Ulothrix flacca (C)				13		A	8.0
Balanus eburneus (B)		1	1				9.0

Appendix C.3 (Continued)

SPECIES	SPRING 1980	SUMMER 1980	FALL 1980	WINTER 1981	SUMMER 1981	SUMMER 1982	OVERALL RANK
			SPI MLW				
Enteromorpha sp. (C)	49	75			N	N	1.0
Brachidontec exustus (M)			77	41	O	O	2.0
Cyanophyta		11		11			3.0
Balanus niveus (B)			3		D	D	4.5
Lomentaria baileyana (R)			3		A	A	4.5
Balanus eburneus (B)		1			T	T	7.0
Porphyra sp. (R)				1	A	A	7.0
Gelidium crinale (R)				1			7.0
			SPI -1.0M LEVEL				
Bugula neritina (Br)	1	21	4	12			1.0
Hydroides sp. (P)		8	15	12			2.0
Clavelina sp. (A)			31				3.5
Tubularia crocea (H)	31				N	N	3.5
Lomentaria baileyana (R)		11	7	1			5.0
Sabellaria vulgaris (P)		8	7				6.0
Enteromorpha sp. (C)	1	8		3	O	O	7.0
Molgula manhattensis (A)		9					8.5
Brachidontes exustus (M)		9					8.5
Clavelina picta (A)				8			11.0
Haliclona loosanoffi (Po)			8				11.0
Codium decorticatum (C)			8		D	D	11.0
Amathia distans (Br)				7			13.5
Membranipora tenuis (Br)		4	3				13.5
Leptogorgia virgulata (Co)			5		A	A	16.0
Ostrea equestris (M)			5				16.0
Polysiphonia sp. (R)	5						16.0
Perophora viridis (A)		3	1		T	T	18.5
Dynamena cornicina (H)			4				18.5
Obelia dichotoma (H)			3				20.5
Anguinella palmata (Br)			3		A	A	20.5
Schizoporella errata (Br)	1	1					22.0
Didemnum sp. (A)			1				29.5
Ascidiacea				1			29.5
Diplosoma macdonaldi (A)	1						29.5
Balanus venustus (B)				1			29.5
Ophiothrix angulata (E)		1					29.5
Arbacia punctulata (E)	1						29.5
Bugula grayi (Br)	1						29.5
Anadara ovalis (M)				1			29.5
Anadara transversa (M)			1				29.5
Loimia medusa (P)		1					29.5
Sabella microphthalma (P)	1						29.5
Bryopsis plumosa (C)			1				29.5
Scytosiphon lomentaria (Ph)				1			29.5
Porphyra sp. (R)				1			29.5

Appendix C.4 Percent cover of sessile macrofauna and flora estimated from line transects (75 pts.) at station SPO. A = Ascidian, B = Barnacle, Br = Bryozoan, C = Chlorophyte, Co = Coral, D = Diatom, E = Echinoderm, H = Hydroid, M = Mollusk, P = Polychaete, Ph = Phaeophyte, Po = Porifera, R = Rhodophyte

SPECIES	SPRING 1980	SUMMER 1980	FALL 1980	WINTER 1981	SUMMER 1981	SUMMER 1982	OVERALL RANK
			SPO +2.5M LEVEL				
Cyanophyta				47			1.0
			SPO +2.0M LEVEL				
Cyanophyta		56	65	85	9		1.0
Bangia atropururea (R)				19			2.0
			SPO +1.5M LEVEL				
Chthamalus fragilis (B)		24	56	28	45	4	1.0
Cyanophyta			25	56	41	3	2.0
Erythrotrichia carnea (R)	3	13					3.0
Enteromorpha sp. (C)				15			4.0
			SPO +1.0M LEVEL				
Chthamalus fragilis (B)	5	25	77	83	63	44	1.0
Cyanophyta			36	20	19		2.0
Porphyra sp. (R)	49						3.0
Brachidontes exustus (M)		16	5	8			4.0
Enteromorpha sp. (C)	16	11		1			5.0
Cladophora sp. (C)		20					6.0
Crassostrea virginica (M)		5	8	4	1	1	7.0
Polysiphonia sp. (R)		12					8.0
Balanus eburneus (B)		1					9.0
			SPO +0.5M LEVEL				
Brachidontes exustus (M)		97	80	61	65	8	1.0
Enteromorpha sp. (C)	33	1	7				2.0
Porphyra sp. (R)	29						3.0
Polysiphonia sp. (R)	4	19		1	1		4.0
Cladophora sp. (C)		9	12	3			5.0
Chthamalus fragilis (B)	1					15	6.0
Ulva sp. (C)			11		4		8.0
Callithamnion byssoides (R)				15			8.0
Gracilaria foliifera (R)					15		8.0
Balanus improvisus (B)	4						10.0
Crassostrea virginica (M)						3	12.0

Appendix C.4 (Continued)

SPECIES	SPRING 1980	SUMMER 1980	FALL 1980	WINTER 1981	SUMMER 1981	SUMMER 1982	OVERALL RANK
SPO +0.5M LEVEL							
Chlorophyta A					3		12.0
Lomentaria baileyana (R)		3					12.0
Balanus niveus (B)			1				15.5
Sabellaria vulgaris (P)					1		15.5
Rhodophyta A					1		15.5
Hypnea musciformis (R)		1					15.5
SPO MLW							
Brachidontes exustus (M)		77	73	95	77	9	1.0
Gracilaria foliifera (R)		7	23	28	23	9	2.0
Bryopsis plumosa (C)			15			28	3.0
Ulva sp. (C)		3	5		7	24	4.0
Hypnea musciformis (R)		3				29	5.0
Enteromorpha sp. (C)	19						6.0
Lomentaria baileyana (R)		3	13				7.0
Chthamalus fragilis (B)		11					8.0
Cladophora sp. (C)				7			9.5
Chlorophyta A					7		9.5
Balanus improvisus (B)	4		1				11.0
Polysiphonia sp. (R)		3	1				12.0
Membranipora tenuis (Br)		3					13.5
Hydroides sp. (P)		3					13.5
Balanus eburneus (B)					1		17.5
Tubularia crocea (H)	1						17.5
Crassostrea virginica (M)		1					17.5
Licmophora sp. (D)				1			17.5
Porphyra sp. (R)	1						17.5
Rhodophyta A					1		17.5
SPO -1.0M LEVEL							
Brachidontes exustus (M)		55	53	76	71	N	1.0
Obelia dichotoma (H)		7	15			O	2.5
Sabellaria vulgaris (P)	5	8	9				2.5
Polysiphonia sp. (R)		13				D	4.0
Tubularia crocea (H)	11		1			A	5.0
Lomentaria baileyana (R)		1	7	3		T	6.0
Balanus improvisus (B)	1	7		1		A	7.5
Gracilaria foliifera (R)					9		7.5

Appendix C.4 (Continued)

SPECIES	SPRING 1980	SUMMER 1980	FALL 1980	WINTER 1981	SUMMER 1981	SUMMER 1982	OVERALL RANK
SPO -1.0M LEVEL							
Hydroides sp. (P)			7			1	9.0
Balanus venustus (B)				7			10.5
Bugula neritina (Br)		3	3	1			10.5
Membranipora tenuis (Br)		3	3				12.0
Obelia geniculata (H)					4		15.5
Alcyonidium polyoum (Br)	1	3					15.5
Electra monostachys (Br)	4						15.5
Chlorophyta A				4			15.5
Porphyra sp. (R)				4			15.5
Hypnea musciformis (R)				4			15.5
Perophora viridis (A)					3		19.0
Molgula manhattensis (A)	1			1			20.5
Schizoporella errata (Br)		1	1				20.5
Porifera A					1		29.0
Balanus niveus (B)			1				29.0
Halocordyle disticha (H)			1				29.0
Bougainvillia rugosa (H)		1					29.0
Plumularia floridana (H)			1				29.0
Bougainvillia sp. (H)		1					29.0
Asterias forbesii (E)	1						29.0
Anguinella palmata (Br)			1				29.0
Parasmittina nitida (Br)	1						29.0
Astyris lunata (M)		1					29.0
Musculus lateralis (M)			1				29.0
Ostrea equestris (M)			1				29.0
Pelecypoda (M)			1				29.0
Ulva sp. (C)				1			29.0
Bryopsis plumosa (C)			1				29.0

APPENDIX D: PERCENT COVER OF SESSILE MACROFAUNA AND FLORA ESTIMATED FROM PHOTOGRAPHIC QUADRATS-SOUTH JETTY STATIONS

Appendix D.1 Percent cover of sessile macrofauna and flora estimated from photographic quadrats (150 cm^2) at station SEI. A = Ascidian, B = Barnacle, Br = Bryozoan, C = Chlorophyte, Co = Coral, E = Echinoderm, H = Hydroid, M = Mollusk, P = Polychaete, Po = Porifera, R = Rhodophyte.

ECIES	SPRING 1980	SUMMER 1980	FALL 1980	WINTER 1981	SUMMER 1981	SUMMER 1982	OVERALL RANK
			SEI +2.5M LEVEL				
			NO BIOTA				
			SEI +2.0M LEVEL				
Chthamalus fragilis (B)				No Data			1.0
			SEI +1.5M LEVEL				
Chthamalus fragilis (B)	1	41	11	55	30	19	1.0
Crassostrea virginica (M)						3	2.0
			SEI +1.0M LEVEL				
Chthamalus fragilis (B)	35	N	76	52	N	8	1.0
Porphyra sp. (R)	60	O			O		2.0
Chlorophyta	29						3.0
Crassostrea virginica (M)		D	9	1	D	1	4.0
Brachidontes exustus (M)		A			A	7	5.0
Enteromorpha sp. (C)	1	T			T		6.0
		A			A		
			SEI +0.5M LEVEL				
Chthamalus fragilis (B)	24	42	32	16	N	N	1.0
Crassostrea virginica (M)			54	48	O	O	2.0
Porphyra sp. (R)	77						3.0
Brachidontes exustus (M)				27	D	D	4.0
Balanus eburneus (B)	6		5		A	A	5.0
Balanus sp. (B)		1	1		T	T	6.0
Rhodophyta	1				A	A	7.0
			SEI MLW				
Entermorpha sp. (C)	83	8			N	N	1.0
Brachidontes exustus (M)			42	41	O	O	2.0
Balanus eburneus (B)		5					3.0
Chthamalus fragilis (B)	1				D	D	5.0
Balanus sp. (B)	1				A	A	5.0
Chlorophyta	1				T	T	5.0
					A	A	

Appendix D.2 Percent cover of sessile macrofauna and flora estimated from photograhic quadrats (150 cm^2) at station SEO. A = Ascidian, B = Barnacle, Br = Bryozoan, C = Chlorophyte, Co = Coral, E = Echinoderm, H = Hydroid, M = Mollusk, P = Polychaete, Po = Porifera, R = Rhodophyte.

SPECIES	SPRING 1980	SUMMER 1980	FALL 1980	WINTER 1981	SUMMER 1981	SUMMER 1982	OVERALL RANK
			SEO +2.5M LEVEL				
			NO BIOTA				
			SEO +2.0M LEVEL				
Chthamalus fragilis (B)						No Data	1.0
Enteromorpha sp. (C)		1					2.0
			SEO +1.5M LEVEL				
Chthamalus fragilis (B)		55	36	52	60	2	1.0
Chlorophyta		1					2.5
Porphyra sp. (R)					1		2.5
			SEO +1.0M LEVEL				
Chthamalus fragilis (B)		46	77	78	49	26	1.0
Chlorophyta	1	19			1		2.0
Brachidontes exustus (M)		3	2	1	10	1	3.0
Crassostrea virginica (M)		4	1	1	2	2	4.0
Porphyra sp. (R)					3		5.0
			SEO +0.5M LEVEL				
Brachidontes exustus (M)		81	95	82	75	10	1.0
Chthamalus fragilis (B)				3		21	2.0
Enteromorpha sp. (C)	3	12					3.0
Ulva sp. (C)		9	2				4.0
Cladophora sp. (C)		7					5.0
Crassostrea virginica (M)			2			4	6.0
Balanus sp. (B)	4						7.0
Gracilaria foliifera (R)			2				8.0
Chlorophyta A					1		9.0
			SEO MLW				
Brachidontes exustus (M)		76	N	98	39	1	1.0
Ulva sp. (C)		22	O		5	53	2.0
Enteromorpha sp. (C)	6	2		18			3.0
Balanus sp. (B)	9		D				4.0
Hydroides sp. (P)			A		3	3	5.5
Chlorophyta			T		5	1	5.5
Hypnea musciformis (R)		4	A			1	7.0
Crassostrea virginica (M)						3	8.0
Rhodophyta				2			9.0

Appendix D.3 Percent cover of sessile macrofauna and flora estimated from photographic quadrats (150 cm^2) at station SPI. A = Ascidian, B = Barnacle, Br = Bryozoan, C = Chlorophyte, Co = Coral, E = Echinoderm, H = Hydroid, M = Mollusk, P = Polychaete, Po = Porifera, R = Rhodophyte.

SPECIES	SPRING 1980	SUMMER 1980	FALL 1981	WINTER 1981	SUMMER 1981	SUMMER 1982	OVERALL RANK
			SPI +2.5M LEVEL				
			NO BIOTA				
			SPI +2.0M LEVEL				
			NO BIOTA				
			SPI +1.5M LEVEL				
Chthamalus fragilis (B)			8		No Data	14	1.0
			SPI +1.0M LEVEL				
Chthamalus fragilis (B)		16	65	49	43	3	1.0
Porphyra sp. (R)	42						2.0
Crassostrea virginica (M)						22	3.0
Chlorophyta	16						4.0
Brachidontes exustus (M)						1	5.0
			SPI +0.5M LEVEL				
Crassostrea virginica (M)		7	42	20	34	N	1.0
Enteromorpha sp. (C)	16	28				O	2.0
Chthamalus fragilis (B)		4	9	2	17		3.0
Porphyra sp. (R)	28					D	4.0
Ulva sp. (C)	19					A	5.0
Brachidontes exustus (M)		5			13	T	6.0
Chlorophyta	1					A	7.0
			SPI MLW				
Brachidontes exustus (M)			65	57	N	N	1.0
Enteromorpha sp. (C)	51	58			O	O	2.0
Ulva sp. (C)	6						3.5
Chlorophyta			6		D	D	3.5
Crassostrea virginica (M)			1	3	A	A	5.0
Balanus eburneus (B)		3			T	T	6.5
Polysiphonia sp. (R)	3				A	A	6.5
Balanus improvisus (B)			1	1			8.0

Appendix D.3 (Continued)

SPECIES	SPRING 1980	SUMMER 1980	FALL 1980	WINTER 1981	SUMMER 1981	SUMMER 1982	OVERALL RANK
			SPI -1.0M LEVEL				
Clavelina picta (A)			29	14			1.0
Tubularia crocea (H)	30				N	N	2.0
Bugula neritina (Br)	4	18		7			3.0
Leptogorgia virgulata (Co)			9		O	O	4.0
Hydroides sp. (P)	1	1	1	3			5.5
Undetermined biota	5		1				5.5
Ascidiacea			4				8.0
Codium decorticatum (C)			4		D	D	8.0
Rhodophyta		4					8.0
Membranipora tenuis (Br)				3	A	A	10.5
Bryozoa	3						10.5
Molgula manhattensis (A)		2			T	T	14.0
Schizoporella errata (Br)	1	1					14.0
Brachidontes exustus (M)		2			A	A	14.0
Algae			1	1			14.0
Chlorophyta		2					14.0
Perophora viridis (A)		1					20.0
Aplidium sp. (A)		1					20.0
Distaplia bermudensis (A)			1				20.0
Balanus sp. (B)		1					20.0
Astrangia astreiformis (Co)			1				20.0
Ulva sp. (C)				1			20.0
Hypnea musciformis (R)			1				20.0

Appendix D.4 Percent cover of sessile macrofauna and flora estimated from photographic quadrats (150 cm^2) at station SPO. A = Ascidian, B = Barnacle, Br = Bryozoan, C = Chlorophyte, Co = Coral, E = Echinoderm, H = Hydroid, M = Mollusk, P = Polychaete, Po = Porifera, R = Rhodophyte.

SPECIES	SPRING 1980	SUMMER 1980	FALL 1980	WINTER 1981	SUMMER 1981	SUMMER 1982	OVERALL RANK
			SPO +2.5M LEVEL				
			NO BIOTA				
			SPO +2.0M LEVEL				
			NO BIOTA				
			SPO +1.5M LEVEL				
Chthamalus fragilis (B)		11	No Data	16	43	23	1.0
Chlorophyta	1						2.0
			SPO +1.0M LEVEL				
Chthamalus fragilis (B)	2	32	71	72	71	28	1.0
Porphyra sp. (R)	52						2.0
Enteromorpha sp. (C)	21	17					3.0
Brachidontes exustus (M)		8	10	11			4.0
Cladophora sp. (C)		23					5.0
Crassostrea virginica (M)		2	1	2	1		6.0
Polysiphonia sp. (R)		1					7.0
			SPO +0.5M LEVEL				
Brachidontes exustus (M)		99	82	64	63	3	1.0
Enteromorpha sp. (C)	49					8	2.0
Cladophora sp. (C)		38					3.0
Chlorophyta			28				4.0
Porphyra sp. (R)	22						5.0
Gracilaria folifera (R)					10		6.0
Chthamalus fragilis (B)				1		7	7.0
Ulva sp. (C)		1			6		8.0
Hypnea musciformis (R)					3		9.0
Crassostrea virginica (M)						2	10.5
Rhodophyta		1	1				10.5
Balanus sp. (B)	1						14.0
Hydroides sp. (P)						1	14.0
Sabellaria vulgaris (P)		1					14.0
Polysiphonia sp. (R)	1						14.0
Undetermined biota					1		14.0

Appendix D.4 (Continued)

SPECIES	SPRING 1980	SUMMER 1980	FALL 1980	WINTER 1981	SUMMER 1981	SUMMER 1982	OVERALL RANK
SPO MLW							
Brachidontes exustus (M)				79	66	1	1.0
Ulva sp. (C)		N	N		3	30	2.0
Gracilaria foliifera (R)		O	O	16	4	10	3.0
Enteromorpha sp. (C)	26					2	4.0
Hypnea musciformis (R)					1	23	5.0
Bryopsis plumosa (C)		D	D			18	6.0
Rhodymenia pseudopalmata (R)		A	A	15	1		7.0
Porphyra sp. (R)	4	T	T				8.0
Algae		A	A			3	9.0
Hydroides sp. (P)					1	1	10.5
Sabellaria vulgaris (P)					1	1	10.5
Lomentaria baileyana (R)					1		12.5
Undetermined biota						1	12.5
SPO -1.0M LEVEL							
Brachidontes exustus (M)		62	79	88	42		1.0
Undetermined biota		24					2.0
Gracilaria foliifera (R)	N				12	N	3.0
Hydroidea					6		4.0
Hydroides sp. (P)	O	4				O	5.5
Rhodophyta		1			3		5.5
Halocordyle disticha (H)			3				7.5
Sabellaria vulgaris (P)	D	1	2			D	7.5
Tubularia crocea (H)			1	1			11.0
Asterias forbesii (E)	A		2			A	11.0
Schizoporella errata (Br)			2				11.0
Astyris lunata (M)	T	1	1			T	11.0
Ulva sp. (C)					2		11.0
Porifera	A				1	A	16.0
Balanus improvisus (B)		1					16.0
Balanus sp. (B)				1			16.0
Balanus venustus (B)		1					16.0
Bugula neritina (Br)		1					16.0

APPENDIX E: LINE-TRANSECT ESTIMATES OF TOTAL BIOTA COVER ON ROCKS-NORTH AND SOUTH JETTY STATIONS

Appendix E.1 Line-transect estimates of total biota cover on rocks at the north and south jetty stations. Station levels with (-) indicates no data.

	SUMMER 1979				SPRING 1980				SUMMER 1980				FALL 1980				WINTER 1981				SUMMER 1981				SUMMER 1982			
LEVEL	NEI	NEO	NPI	NPO	NEI	NEO	NPI	NPO	NEI	NEO	NPI	NPO	NEI	NEO	NPI	NPO	NEI	NEO	NPI	NPO	NEI	NEO	NPI	NPO	NEI	NEO	NPI	NPO
													NORTH JETTY															
2.5	0	0	0	0					0	1	0	0									0	0	0	0	0	0	0	0
2.0	51	0	35	12					75	83	15	24									81	73	83	11	29	28	3	3
1.5	56	96	47	47					71	25	23	3									99	100	99	100	80	36	87	99
1.0	71	75	83	55					81	81	58	84									85	85	96	100	72	80	64	75
0.5	81	91	75	53					79	100	80	85									97	87	95	99	71	71	59	68
0.0	80	99	84	93					96	98	85	100									96	100	95	92	77	69	75	61
-1.0	79	95	67	95					96	76	85	96									99	93	88	57	85	96	85	87
-2.0	-	79	-	92					-	91	-	93									-	95	-	79	-	88	-	81
LEVEL	SEI	SEO	SPI	SPO	SEI	SEO	SPI	SPO	SEI	SEO	SPI	SPO	SEI	SEO	SPI	SPO	SEI	SEO	SPI	SPO	SEI	SEO	SPI	SPO	SEI	SEO	SPI	SPO
													SOUTH JETTY															
2.5					0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	47	0	0	0	0	0	0	0	0
2.0					0	0	0	0	1	49	0	56	39	79	0	65	8	51	0	85	4	45	0	9	4	1	0	0
1.5					21	0	8	3	89	96	45	36	95	33	27	80	80	91	0	96	64	97	8	87	35	27	32	7
1.0					95	12	73	69	99	79	35	77	87	95	61	95	67	100	83	96	-	92	52	83	20	29	37	45
0.5					93	13	85	69	87	91	96	100	100	97	89	99	100	92	100	80	-	92	79	83	-	52	-	25
0.0					87	14	49	26	41	95	87	93	92	97	80	100	73	100	55	100	-	52	-	91	-	63	-	77
-1.0					-	-	49	37	-	-	71	97	-	-	96	87	-	-	45	95	-	-	-	76	-	-	-	-

Appendix E.2 Photographic estimates of total biota cover on rocks at the north and south jetty stations. Station levels with (-) indicates no data.

	SUMMER 1979				SPRING 1980				SUMMER 1980				FALL 1980				WINTER 1981				SUMMER 1981				SUMMER 1982			
LEVEL	NEI	NEO	NPI	NPO	NEI	NEO	NPI	NPO	NEI	NEO	NPI	NPO	NEI	NEO	NPI	NPO	NEI	NEO	NPI	NPO	NEI	NEO	NPI	NPO	NEI	NEO	NPI	NPO
NORTH JETTY																												
2.5	-	-	-	-					0	0	0	0									0	0	0	0	0	0	0	0
2.0	1	36	13	38					0	2	0	0									0	0	0	0	4	0	0	0
1.5	52	58	38	51					4	6	8	4									56	52	35	29	9	48	15	4
1.0	40	76	54	48					59	72	52	68									61	76	61	76	51	64	52	49
0.5	78	83	44	62					79	77	54	80									98	81	86	94	55	47	45	34
0.0	77	96	88	49					92	96	67	85									100	-	96	-	54	53	52	42
-1.0	84	97	89	97					88	93	75	56									90	87	77	82	92	94	73	93
-2.0	-	100	-	85					-	83	-	86									-	96	-	57	-	85	-	81
LEVEL	SEI	SEO	SPI	SPO	SEI	SEO	SPI	SPO	SEI	SEO	SPI	SPO	SEI	SEO	SPI	SPO	SEI	SEO	SPI	SPO	SEI	SEO	SPI	SPO	SEI	SEO	SPI	SPO
SOUTH JETTY																												
2.5					0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	0	0	0
2.0					0	0	0	0	0	1	0	0	0	0	0	0	-	0	0	0	0	-	-	0	5	2	0	0
1.5					1	0	0	1	41	56	0	11	11	36	8	-	55	52	0	16	30	64	-	43	21	2	14	23
1.0					95	1	58	74	-	73	16	78	84	80	65	81	52	79	49	83	-	66	43	71	15	28	26	28
0.5					91	6	64	72	43	86	44	99	91	99	43	82	90	86	21	64	-	76	60	80	-	35	-	21
0.0					85	15	59	36	13	99	61	-	42	-	65	-	41	98	61	79	-	50	-	74	-	59	-	88
-1.0					-	-	45	-	-	-	33	93	-	-	48	89	-	-	26	89	-	-	-	60	-	-	-	-

APPENDIX F: RANKED ABUNDANCE OF MOTILE MACROINVERTEBRATES COLLECTED BY SLURP GUN-NORTH JETTY STATIONS

Appendix F.1 Ranked abundance of motile macroinvertebrates collected by slurp gun from station NEI. Estimates represent mean number per 65 cm^2 with standard error indicated and Am = Amphipod, D = Decapod, E = Echinoderm, I = Isopod, M = Mollusk, My = Mysid, P = Polychaete, Py = Pycnogonid.

SPECIES	SUMMER, 1979		SUMMER, 1980		SUMMER, 1981		SUMMER, 1982		OVERALL RANK
	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	
NEI +1M LEVEL									
Paradella quadripunctata (I)	10.7	0.7	1.3	0.3	0.3	0.3	11.3	2.8	1.0
Sphaeroma quadridentatum (I)					6.0	5.5	3.0	1.5	2.0
Parhyale hawaiensis (Am)					7.7	4.4	1.0	0.6	3.0
Elasmopus levis (Am)					0.7	0.7			4.0
Caprella penantis (Am)					0.3	0.3	0.3	0.3	5.5
Nemertinea									5.5
NEI MLW									
Caprella penantis (Am)	1.0	1.0	0.3	0.3	11.7	5.2	22.0	21.0	1.0
Elasmopus levis (Am)	9.0	5.7	1.3	0.9	1.7	0.3	0.3	0.3	2.0
Stenothoe sp. (Am)	7.3	3.2			0.3	0.3	2.7	2.7	3.0
Paradella quadripunctata (I)							6.0	1.5	4.5
Astyris lunata (M)	1.3	0.3	4.0	1.5			0.7	0.7	4.5
Xanthidae (D)	3.7	2.7					0.7	0.7	7.0
Jassa falcata (Am)							4.3	4.3	7.0
Ampithoe valida (Am)	0.3	0.3					4.0	2.1	7.0
Nanoplax xanthiformis (D)			2.7	1.7					9.0
Parhyale hawaiensis (Am)							2.3	2.3	10.0
Neopanope sayi (D)					0.7	0.7	1.0	1.0	12.5
Erichsonella filiformis (I)					0.3	0.3	1.3	0.9	12.5
Musculus lateralis (M)							1.7	1.7	12.5
Boonea seminuda (M)	1.7	1.7							12.5
Lembos websteri (Am)	0.7	0.3			0.3	0.3	0.3	0.3	15.5
Paracerceis caudata (I)	1.0	1.0	0.3	0.3					15.5
Podarke obscura (P)	0.7	0.7	0.3	0.3					17.5
Brania clavata (P)			1.0	1.0					17.5
Corophium sp. (Am)							0.7	0.7	20.0
Caprella sp. (Am)					0.7	0.7			20.0
Nereis falsa (P)	0.3	0.3					0.3	0.3	20.0
Palaemonetes pugio (D)	0.3	0.3							26.0
Pinnotheres ostreum (D)					0.3	0.3			26.0
Gammaropsis sp. (Am)							0.3	0.3	26.0
Jaeropsis coralicola (I)							0.3	0.3	26.0
Nymphonidae A (Py)							0.3	0.3	26.0
Amphiodia sp. (E)							0.3	0.3	26.0
Chione grus (M)							0.3	0.3	26.0
Loimia medusa (P)							0.3	0.3	26.0
Nereidae (P)							0.3	0.3	26.0

Appendix F.1 (Continued)

SPECIES	SUMMER, 1979		SUMMER, 1980		SUMMER, 1981		SUMMER, 1982		OVERALL RANK
	$\overline{x}$	SE	$\overline{x}$	SE	$\overline{x}$	SE	$\overline{x}$	SE	
			NEI -1M LEVEL						
Astyris lunata (M)	5.0	2.6	9.3	3.2	5.7	0.3	2.0	0.6	1.0
Amphiodia sp. (E)					9.7	4.0	3.0	1.7	2.0
Paracerceis caudata (I)	4.0	1.0	1.0	0.6	0.3	0.3	4.0	0.6	3.0
Caprella penantis (Am)	1.3	1.3	2.3	1.3	2.3	1.4	1.3	0.3	4.0
Chione grus (M)					0.3	0.3	5.3	3.9	5.0
Melita appendiculata (Am)			0.7	0.7	2.3	2.3	2.0	1.5	6.0
Nanoplax xanthiformis (D)			4.7	0.3					7.0
Elasmopus levis (Am)	1.7	1.2	0.3	0.3	2.0	2.0	0.3	0.3	8.0
Neopanope sayi (D)					1.3	1.3	2.3	0.3	9.0
Xanthidae (D)	1.0	1.0			2.0	1.1			10.5
Urosalpinx cinerea (M)			0.3	0.3	0.7	0.7	2.0	0.6	10.5
Erichthonius brasiliensis (Am)	0.3	0.3	1.0	1.0	0.7	0.3	0.3	0.3	12.0
Gammaropsis sp. (Am)			1.0	0.6	0.3	0.3	0.7	0.7	13.0
Lembos websteri (Am)	0.3	0.3			0.3	0.3	1.0	0.6	14.5
Costoanachis lafresnayi (M)					1.0	0.6	0.7	0.7	14.5
Erichsonella filiformis (I)	0.7	0.3			0.3	0.3	0.3	0.3	17.5
Lembos smithi (Am)			0.3	0.3	1.0	0.6			17.5
Podarke obscura (P)	0.7	0.7			0.7	0.7			17.5
Mediomastus californiensis (P)					1.3	1.3			17.5
Ophiothrix angulata (E)					0.7	0.7	0.3	0.3	21.0
Boonea seminuda (M)	0.7	0.3					0.3	0.3	21.0
Nereis falsa (P)					0.3	0.3	0.7	0.3	21.0
Latreutes parvulus (D)	0.7	0.7							30.5
Pinnotheres maculatus (D)			0.7	0.7					30.5
Caprella equilibra (Am)					0.3	0.3	0.3	0.3	30.5
Stenothoe sp. (Am)	0.7	0.3							30.5
Jassa falcata (Am)			0.7	0.3					30.5
Nemertinea					0.7	0.7			30.5
Turbonilla sp. (M)					0.7	0.7			30.5
Cerithiopsis fusiforme (M)							0.7	0.3	30.5
Aeolidiidae A (M)	0.7	0.7							30.5
Pista palmata (P)					0.7	0.7			30.5
Piromis eruca (P)					0.7	0.7			30.5
Loimia medusa (P)							0.7	0.3	30.5
Brania clavata (P)			0.7	0.7					30.5
Terebellidae (P)			0.7	0.3					30.5
Sabella microphthalma (P)			0.3	0.3	0.3	0.3			30.5
Americardia guppyi (M)					0.3	0.3	0.3	0.3	30.5
Pilumnus sp. (D)					0.3	0.3			51.5
Eurypanopeus depressus (D)	0.3	0.3							51.5
Libinia dubia (D)	0.3	0.3							51.5
Eurypanopeus sp. (D)			0.3	0.3					51.5
Lembos unicornis (Am)			0.3	0.3					51.5
Corophium sp. (Am)							0.3	0.3	51.5

Appendix F.1 (Continued)

SPECIES	SUMMER, 1979		SUMMER, 1980		SUMMER, 1981		SUMMER, 1982		OVERALL RANK
	$\overline{x}$	SE	$\overline{x}$	SE	$\overline{x}$	SE	$\overline{x}$	SE	
			NET -1M LEVEL						
Leucothoe spinicarpa (Am)					0.3	0.3			51.5
Isopoda A	0.3	0.3							51.5
Paradella quadripunctata (I)							0.3	0.3	51.5
Tanystylum orbiculare (Py)			0.3	0.3					51.5
Turbellaria							0.3	0.3	51.5
Nemertinea E			0.3	0.3					51.5
Arbacia punctulata (E)			0.3	0.3					51.5
Musculus lateralis (M)					0.3	0.3			51.5
Semele proficua (M)							0.3	0.3	51.5
Mactra fragilis (M)					0.3	0.3			51.5
Pelecypoda B (M)	0.3	0.3							51.5
Lyonsia hyalina (M)							0.3	0.3	51.5
Epitonium humphreysi (M)							0.3	0.3	51.5
Odostomia laevigata (M)	0.3	0.3							51.5
Timarete sp. (P)			0.3	0.3					51.5
Cirriformia filigera (P)					0.3	0.3			51.5
Polycirrus carolinensis (P)					0.3	0.3			51.5
Nereis sp. (P)			0.3	0.3					51.5
Prionospio cirrifera (P)			0.3	0.3					51.5

Appendix F.2 Ranked abundance of motile macroinvertebrates collected by slurp gun from station NEO. Estimates represent mean number per 65 cm^2 with standard error indicated and Am = Amphipod, D = Decapod, E = Echinoderm, I = Isopod, M = Mollusk, My = Mysid, P = Polychaete, Py = Pycnogonid.

SPECIES	SUMMER, 1979		SUMMER, 1980		SUMMER, 1981		SUMMER, 1982		OVERALL RANK
	$\overline{x}$	SE	$\overline{x}$	SE	$\overline{x}$	SE	$\overline{x}$	SE	
			NEO +1M LEVEL						
Paradella quadripunctata (I)	4.0	1.0	2.0	0.6	0.3	0.3	5.7	1.8	1.0
Parhyale hawaiensis (Am)							5.0	1.5	2.0
Elasmopus levis (Am)			0.3	0.3	1.3	1.3			3.0
Sphaeroma quadridentatum (I)					0.3	0.3	1.0	0.6	4.0
Erichthonius brasiliensis (Am)					0.7	0.7			5.0
Gammaropsis sp. (Am)					0.3	0.3			9.0
Corophium sp. A (Am)	0.3	0.3							9.0
Stenothoe sp. (Am)					0.3	0.3			9.0
Caprella penantis (Am)	0.3	0.3							9.0
Ampithoe valida (Am)	0.3	0.3							9.0
Nemertinea							0.3	0.3	9.0
Nereis succinea (P)					0.3	0.3			9.0
			NEO MLW						
Elasmopus levis (Am)	17.3	7.9	3.7	1.2	7.0	6.0			1.0
Caprella penantis (Am)			0.3	0.3	17.7	11.2			2.0
Paradella quadripunctata (I)							10.0	5.8	3.0
Stenothoe sp. (Am)	5.0	1.5			1.0	0.6			4.0
Jassa falcata (Am)					2.3	0.9			5.0
Neopanope sayi (D)					1.0	0.6			9.5
Nanoplax xanthiformis (D)			1.0	0.6					9.5
Xanthidae (D)	1.0	1.0							9.5
Ampithoe longimana (Am)	1.0	1.0							9.5
Gammaropsis sp.(Am)			1.0	0.6					9.5
Erichsonella filiformis (I)					1.0	0.6			9.5
Astyris lunata (M)			1.0	1.0					9.5
Podarke obscura (P)	1.0	0.6							9.5
Pinnotheres ostreum (D)					0.7	0.7			15.5
Sphaeroma quadridentatum (I)							0.7	0.7	15.5
Caprella sp. (Am)					0.7	0.7			15.5
Nereis falsa (P)	0.3	0.3			0.3	0.3			15.5
Lembos websteri (Am)					0.3	0.3			21.0
Caprella equilibra (Am)					0.3	0.3			21.0
Elasmopus sp. (Am)					0.3	0.3			21.0
Melita appendiculata (Am)			0.3	0.3					21.0
Nudibranchia (M)					0.3	0.3			21.0
Musculus lateralis (M)					0.3	0.3			21.0
Boonea seminuda (M)	0.3	0.3							

Appendix F.2 (Continued)

SPECIES	SUMMER, 1979 $\overline{x}$	SUMMER, 1979 SE	SUMMER, 1980 $\overline{x}$	SUMMER, 1980 SE	SUMMER, 1981 $\overline{x}$	SUMMER, 1981 SE	SUMMER, 1982 $\overline{x}$	SUMMER, 1982 SE	OVERALL RANK
NEO -1M LEVEL									
Caprella penantis (Am)	3.3	1.7	2.3	1.8	15.0	6.8	5.0	1.5	1.0
Elasmopus levis (Am)	11.0	2.5	4.7	2.7	5.7	1.3	0.3	0.3	2.0
Stenothoe sp. (Am)	1.3	0.9	3.7	2.7	6.0	3.5	0.3	0.3	3.0
Jassa falcata (Am)			5.0	5.0	3.3	0.7	2.0	1.5	4.0
Paracerceis caudata (I)	0.7	0.3	1.7	0.3	2.0	2.0	4.0	2.5	5.0
Gammaropsis sp. (Am)			2.0	0.6	3.7	0.3	2.3	0.7	6.0
Astyris lunata (M)	0.3	0.3	2.3	1.4	3.0	1.1	1.3	0.3	7.0
Erichsonella filiformis (I)	0.3	0.3			0.3	0.3	2.7	1.2	8.0
Nematoda			3.0	3.0					9.5
Brania clavata (P)			3.0	3.0					9.5
Corophium sp. (Am)			1.7	0.9			0.7	0.3	11.0
Nanoplax xanthiformis (D)			1.7	0.9					12.5
Caprella equilibra (Am)					1.7	1.2			12.5
Erichthonius brasiliensis (Am)					0.7	0.3	0.7	0.3	14.0
Neopanope sayi (D)					1.0	1.0			17.0
Lembos websteri (Am)					0.3	0.3	0.7	0.3	17.0
Melita appendiculata (Am)			1.0	0.6					17.0
Urosalpinx cinerea (M)					0.7	0.7	0.3	0.3	17.0
Chione grus (M)							1.0	1.0	17.0
Latreutes parvulus (D)	0.7	0.3							24.0
Paracaprella tenuis (Am)					0.7	0.7			24.0
Melita dentata (Am)	0.7	0.7							24.0
Ampithoe valida (Am)	0.7	0.7							24.0
Asterias forbesii (E)	0.7	0.7							24.0
Amphiodia sp. (E)					0.3	0.3	0.3	0.3	24.0
Petricola pholadiformis (M)							0.7	0.7	24.0
Costoanachis lafresnayi (M)							0.7	0.3	24.0
Podarke obscura (P)	0.7	0.7							24.0
Euceramus praelongus (D)					0.3	0.3			35.5
Xanthidae (D)							0.3	0.3	35.5
Xanthidae A (D)	0.3	0.3							35.5
Micropanope sp. (D)					0.3	0.3			35.5
Amphipoda							0.3	0.3	35.5
Phoxichiliidae (Py)							0.3	0.3	35.5
Ophiothrix angulata (E)					0.3	0.3			35.5
Musculus lateralis (M)							0.3	0.3	35.5
Boonea seminuda (M)					0.3	0.3			35.5
Pelecypoda A (M)	0.3	0.3							35.5
Pelecypoda D (M)	0.3	0.3							35.5
Pista palmata (P)					0.3	0.3			35.5
Prionospio sp. (P)							0.3	0.3	35.5
Nereis falsa (P)	0.3	0.3							35.5

Appendix F.2 (Continued)

SPECIES	SUMMER, 1979 $\overline{x}$	SUMMER, 1979 SE	SUMMER, 1980 $\overline{x}$	SUMMER, 1980 SE	SUMMER, 1981 $\overline{x}$	SUMMER, 1981 SE	SUMMER, 1982 $\overline{x}$	SUMMER, 1982 SE	OVERALL RANK
NEO -2M LEVEL									
Astyris lunata (M)	1.7	1.2	8.7	3.0	8.7	1.8	3.0	2.1	1.0
Melita appendiculata (Am)					2.3	1.2	6.3	5.4	2.0
Chione grus (M)							7.3	3.5	3.0
Gammaropsis sp. (Am)			0.3	0.3	3.0	2.5	3.3	1.2	4.0
Lembos smithi (Am)	0.3	0.3	2.0	2.0	2.0	1.0	1.7	0.9	5.0
Paracerceis caudata (I)	2.7	0.7	0.7	0.3	0.7	0.3	1.7	0.7	6.0
Neopanope sayi (D)					3.0	1.0	2.3	1.3	7.0
Amphiodia sp. (E)					2.7	0.9	2.0	1.5	8.0
Elasmopus levis (Am)	2.7	2.2			1.3	0.3	0.3	0.3	9.0
Pinnotheres ostreum (D)	3.7	0.9							10.5
Brania clavata (P)			3.7	2.0					10.5
Lembos websteri (Am)					2.3	0.7	0.7	0.7	12.0
Nanoplax xanthiformis (D)			2.0	0.6					14.5
Erichthonius brasiliensis (Am)	1.0	0.6					1.0	1.0	14.5
Caprella penantis (Am)	0.7	0.7	0.7	0.3	0.7	0.3			14.5
Ophiothrix angulata (E)					2.0	1.0			14.5
Costoanachis lafresnayi (M)					1.0	1.0	0.7	0.3	17.0
Pelia mutica (D)	0.3	0.3			1.0	0.6			18.5
Cerithiopsis sp. (M)			1.0	0.6			0.3	0.3	18.5
Majidae (D)			1.0	0.6					24.5
Micropanope sp. (D)					1.0	1.0			24.5
Lembos unicornis (Am)			1.0	0.6					24.5
Erichsonella filiformis (I)					0.3	0.3	0.7	0.7	24.5
Corophium sp. (Am)			1.0	0.6					24.5
Stenothoe sp. (Am)					1.0	0.6			24.5
Boonea seminuda (M)	1.0	0.6							24.5
Odostomia laevigata (M)	1.0	0.6							24.5
Aeolidiidae A (M)	1.0	1.0							24.5
Podarke obscura (P)	1.0	0.6							24.5
Paracaprella tenuis (Am)			0.3	0.3	0.3	0.3			31.0
Petricola pholadiformis (M)							0.7	0.7	31.0
Pista palmata (P)					0.3	0.3	0.3	0.3	31.0
Latreutes parvulus (D)					0.3	0.3			43.5
Xanthidae (D)	0.3	0.3							43.5
Thor floridanus (D)							0.3	0.3	43.5
Pinnotheres sp. (D)			0.3	0.3					43.5
Unciola serrata (Am)							0.3	0.3	43.5
Caprellidae (Am)					0.3	0.3			43.5
Jassa falcata (Am)			0.3	0.3					43.5
Nemertinea					0.3	0.3			43.5
Asterias forbesii (E)	0.3	0.3							43.5

Appendix F.2 (Continued)

SPECIES	SUMMER, 1979		SUMMER, 1980		SUMMER, 1981		SUMMER, 1982		OVERALL RANK
	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	
			NEO - 2M LEVEL						
Urosalpinx cinerea (M)							0.3	0.3	43.5
Musculus lateralis (M)							0.3	0.3	43.5
Turbonilla sp. (M)							0.3	0.3	43.5
Diplodonta sp. (M)							0.3	0.3	43.5
Americardia guppyi (M)							0.3	0.3	43,5
Epitonium apiculatum (M)					0.3	0.3			43.5
Petricola typica (M)							0.3	0.3	43.5
Sipunculida							0.3	0.3	43.5
Megalomma bioculatum (P)							0.3	0.3	43.5
Potamilla sp. B (P)			0.3	0.3					43.5
Nereis falsa (P)					0.3	0.3			43.5
Pseudeurythoe ambigua (P)							0.3	0.3	43.5
Nereis succinea (P)			0.3	0.3					43.5

Appendix F.3 Ranked abundance of motile macroinvertebrates collected by slurp gun from station NPI. Estimates represent mean number per 65 cm^2 with standard error indicated and Am = Amphipod, D = Decapod, E = Echinoderm, I = Isopod, M = Mollusk, My = Mysid, P = Polychaete, Py = Pycnogonid.

SPECIES	SUMMER, 1979		SUMMER, 1980		SUMMER, 1981		SUMMER, 1982		OVERALL RANK
	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	
			NPI +1M LEVEL						
Paradella quadripunctata (I)	47.7	39.7	1.0	0.6			0.3	0.3	1.0
Nemertinea	2.7	2.7							2.0
Sphaeroma quadridentatum (I)					0.7	0.7			3.0
Erichsonella filiformis (I)					0.3	0.3			4.5
Brania clavata (P)	0.3	0.3							4.5
			NPI MLW						
Elasmopus levis (Am)	5.3	2.6	0.7	0.3	0.7	0.7			1.0
Paradella quadripunctata (I)	3.0	0.6	2.0	1.1			0.3	0.3	2.0
Caprella penantis (Am)	0.7	0.7	1.0	1.0	2.7	0.9			3.5
Brania clavata (P)	4.3	1.2							3.5
Pinnotheres ostreum (D)	1.7	0.3							5.5
Stenothoe sp. (Am)	1.7	0.9							5.5
Ampithoe valida (Am)	1.3	0.9							7.0
Paracerceis caudata (I)					1.0	0.6			8.5
Astyris lunata (M)			0.7	0.7	0.3	0.3			8.5
Neopanope sayi (D)					0.7	0.7			11.5
Erichthonius brasiliensis (Am)					0.7	0.7			11.5
Jassa falcata (Am)			0.3	0.3	0.3	0.3			11.5
Petricola pholadiformis (M)			0.3	0.3	0.3	0.3			11.5
Xanthidae (D)	0.3	0.3							19.5
Lembos unicornis (Am)			0.3	0.3					19.5
Gammaropsis sp. (Am)					0.3	0.3			19.5
Erichsonella filiformis (I)					0.3	0.3			19.5
Caprella equilibra (Am)			0.3	0.3					19.5
Corophium sp. (Am)			0.3	0.3					19.5
Corophiidae (Am)	0.3	0.3							19.5
Melita appendiculata (Am)					0.3	0.3			19.5
Nemertinea			0.3	0.3					19.5
Nereis falsa (P)	0.3	0.3							19.5
Podarke obscura (P)	0.3	0.3							19.5
Nereidae (P)	0.3	0.3							19.5

Appendix F.3 (Continued)

SPECIES	SUMMER, 1979 $\overline{x}$	SUMMER, 1979 SE	SUMMER, 1980 $\overline{x}$	SUMMER, 1980 SE	SUMMER, 1981 $\overline{x}$	SUMMER, 1981 SE	SUMMER, 1982 $\overline{x}$	SUMMER, 1982 SE	OVERALL RANK
NPI -1M LEVEL									
Paracerceis caudata (I)	2.3	1.2	4.3	2.4	0.3	0.3	13.0	3.8	1.0
Erichthonius brasiliensis (Am)					18.0	5.8			2.0
Astyris lunata (M)	0.3	0.3	3.7	1.7	10.3	3.8	2.3	0.3	3.0
Amphiodia sp. (E)			1.3	0.9	12.7	5.6	0.7	0.7	4.5
Brania clavata (P)	13.7	8.8			0.3	0.3	0.7	0.7	4.5
Elasmopus levis (Am)	8.0	3.8	4.0	1.1	1.0	1.0			6.0
Corophium sp. (Am)			5.0	3.5	0.3	0.3	3.0	2.1	7.0
Caprella penantis (Am)	1.0	0.6	1.3	0.9	2.7	1.7	2.7	1.2	8.0
Neopanope sayi (D)			1.7	0.7	4.7	2.6			10.0
Stenothoe sp. (Am)	4.7	2.0	0.3	0.3	1.0	0.6	0.3	0.3	10.0
Melita appendiculata (Am)			2.7	0.3	3.7	1.4			10.0
Gammaropsis sp. (Am)			4.0	1.5	1.3	0.7	0.3	0.3	12.0
Urosalpinx cinerea (M)			1.7	0.7	1.3	1.3	2.0	1.5	13.0
Lembos unicornis (Am)	0.7	0.7	3.7	3.7	0.3	0.3			14.5
Erichsonella filiformis (I)			1.0	0.6	1.7	1.2	2.0	0.6	14.5
Mediomastus californiensis (P)	1.7	0.9	2.7	1.4					16.0
Nereis falsa (P)	1.3	0.7			0.3	0.3	1.0	1.0	17.0
Podarke obscura (P)	0.7	0.3	0.7	0.3	0.7	0.3	0.3	0.3	18.0
Caprella equilibra (Am)					2.0	2.0			19.0
Lembos websteri (Am)							1.7	0.9	20.5
Nemertinea			1.7	0.9					20.5
Costoanachis lafresnayi (M)					1.0	0.6	0.3	0.3	22.0
Latreutes parvulus (D)	0.7	0.7			0.3	0.3			26.5
Pinnotheres ostreum (D)	1.0	0.6							26.5
Lembos smithi (Am)	0.3	0.3					0.7	0.7	26.5
Paracaprella tenuis (Am)					1.0	0.6			26.5
Melita dentata (Am)	1.0	1.0							26.5
Ophiothrix angulata (E)			0.7	0.3	0.3	0.3			26.5
Pelecypoda A (M)	1.0	0.6							26.5
Pherusa ehlersi (P)			1.0	1.0					26.5
Xanthidae (D)	0.3	0.3			0.3	0.3			35.0
Paradella quadripunctata (I)	0.7	0.3							35.0
Trachycardium muricatum (M)	0.7	0.3							35.0
Timarete sp. (P)			0.3	0.3			0.3	0.3	35.0
Piromis eruca (P)							0.7	0.7	35.0
Nereis succinea (P)			0.7	0.7					35.0
Cirratulidae (P)	0.3	0.3	0.3	0.3					35.0
Schistomeringos rudolphi (P)			0.7	0.7					35.0
Prionospio cirrifera (P)	0.7	0.3							35.0
Pilumnus sp. (D)							0.3	0.3	53.5
Pinnotheres sp. (D)							0.3	0.3	53.5
Lysianopsis alba (Am)							0.3	0.3	53.5
Cerapus tubularis (Am)							0.3	0.3	53.5

Appendix F.3 (Continued)

SPECIES	SUMMER, 1979		SUMMER, 1980		SUMMER, 1981		SUMMER, 1982		OVERALL RANK
	$\overline{x}$	SE	$\overline{x}$	SE	$\overline{x}$	SE	$\overline{x}$	SE	
			NPI -1M LEVEL						
Jaeropsis coralicola (I)							0.3	0.3	53.5
Lysianassidae (Am)					0.3	0.3			53.5
Lembos sp. (Am)					0.3	0.3			53.5
Ampithoe valida (Am)	0.3	0.3							53.5
Amphipoda					0.3	0.3			53.5
Amphipoda A	0.3	0.3							53.5
Tanystylum orbiculare (Py)					0.3	0.3			53.5
Anoplodactylus petiolatus (Py)							0.3	0.3	53.5
Nymphonidae A (Py)							0.3	0.3	53.5
Holothuroidea (E)	0.3	0.3							53.5
Nematoda	0.3	0.3							53.5
Musculus lateralis (M)							0.3	0.3	53.5
Boonea seminuda (M)							0.3	0.3	53.5
Chione grus (M)							0.3	0.3	53.5
Chione sp. (M)			0.3	0.3					53.5
Mytilidae (M)							0.3	0.3	53.5
Sipunculida							0.3	0.3	53.5
Sipunculida A					0.3	0.3			53.5
Eunice antennata (P)			0.3	0.3					53.5
Lumbrineris inflata (P)			0.3	0.3					53.5
Loimia medusa (P)							0.3	0.3	53.5
Phyllodoce castanea (P)			0.3	0.3					53.5
Polydora caeca (P)			0.3	0.3					53.5
Sabella microphthalma (P)			0.3	0.3					53.5

Appendix F.4 Ranked abundance of motile macroinvertebrates collected by slurp gun from station NPO. Estimates represent mean number per 65 cm^2 with standard error indicated and Am = Amphipod, D = Decapod, E = Echinoderm, I = Isopod, M = Mollusk, My = Mysid, P = Polychaete, Py = Pycnogonid.

SPECIES	SUMMER, 1979		SUMMER, 1980		SUMMER, 1981		SUMMER, 1982		OVERALL RANK
	$\overline{x}$	SE	$\overline{x}$	SE	$\overline{x}$	SE	$\overline{x}$	SE	
			NPO +1M LEVEL						
Paradella quadripunctata (I)	14.0	1.7	1.7	0.3	0.3	0.3	1.0	0.6	1.0
Sphaeroma quadridentatum (I)					2.0	0.0			2.0
Corophium sp. (Am)							0.7	0.3	3.0
Erichsonella filiformis (I)	0.3	0.3							5.5
Stenothoe sp. (Am)	0.3	0.3							5.5
Parhyale hawaiensis (Am)					0.3	0.3			5.5
Pelecypoda C (M)	0.3	0.3							5.5
			NPO MLW						
Paradella quadripunctata (I)	22.7	9.8	0.7	0.7			3.0	1.1	1.0
Caprella penantis (Am)					6.0	3.0	13.3	1.8	2.0
Corophium sp. (Am)			1.7	0.7	0.3	0.3	6.3	1.8	3.0
Jassa falcata (Am)	1.3	0.9					3.7	0.9	4.0
Stenothoe sp. (Am)	1.0	1.0			0.3	0.3	0.7	0.3	5.0
Elasmopus levis (Am)	0.3	0.3	0.3	0.3	1.0	0.6			6.0
Erichsonella filiformis (I)					1.0	1.0	0.3	0.3	7.5
Ampithoe valida (Am)					0.7	0.3	0.7	0.3	7.5
Caprella equilibra (Am)					1.0	0.6			9.0
Erichthonius brasiliensis (Am)					0.7	0.3			11.5
Paracerceis caudata (I)					0.3	0.3	0.3	0.3	11.5
Corophium sp. A (Am)	0.7	0.3							11.5
Isopoda							0.7	0.3	11.5
Nanoplax xanthiformis (D)			0.3	0.3					19.0
Pinnotheres ostreum (D)					0.3	0.3			19.0
Lembos unicornis (Am)					0.3	0.3			19.0
Lembos websteri (Am)					0.3	0.3			19.0
Jaeropsis coralicola (I)							0.3	0.3	19.0
Nemertinea			0.3	0.3					19.0
Nematoda					0.3	0.3			19.0
Nudibranchia (M)			0.3	0.3					19.0
Astyris lunata (M)					0.3	0.3			19.0
Chione grus (M)							0.3	0.3	19.0
Loimia medusa (P)							0.3	0.3	19.0

Appendix F.4 (Continued)

SPECIES	SUMMER, 1979 x̄	SE	SUMMER, 1980 x̄	SE	SUMMER, 1981 x̄	SE	SUMMER, 1982 x̄	SE	OVERALL RANK
			NPO -1M LEVEL						
Corophium sp. (Am)			4.3	1.2	9.3	5.9	23.7	23.2	1.0
Melita appendiculata (Am)					20.0	17.5	0.3	0.3	2.0
Lembos websteri (Am)					9.0	4.7			3.0
Elasmopus levis (Am)	6.7	3.2	0.3	0.3	0.7	0.7	0.3	0.3	4.0
Caprella penantis (Am)	1.3	1.3			3.3	2.4	2.7	0.9	5.0
Paracerceis caudata (I)	0.3	0.3	0.3	0.3	1.7	0.9	4.3	1.8	6.5
Stenothoe sp. (Am)	5.0	1.7	0.3	0.3	0.3	0.3	1.0	1.0	6.5
Amphiodia sp. (E)					4.7	2.0	0.3	0.3	8.0
Urosalpinx cinerea (M)					4.3	2.3			9.0
Astyris lunata (M)			1.3	0.3	2.7	2.2			10.0
Gammaropsis sp. (Am)			0.3	0.3	2.7	2.7	0.3	0.3	12.0
Microdeutopus sp. (Am)	3.3	2.8							12.0
Erichthonius brasiliensis (Am)	0.7	0.7	0.3	0.3	2.3	1.4			12.0
Corophium sp. A (Am)	3.0	1.5							14.0
Jassa falcata (Am)			0.7	0.7			1.0	1.0	15.0
Erichsonella filiformis (I)					1.0	1.0	0.3	0.3	16.0
Pinnotheres ostreum (D)	1.0	0.0							17.0
Lembos smithi (Am)					0.3	0.3	0.3	0.3	21.5
Unciola serrata (Am)					0.7	0.7			21.5
Jaeropsis coralicola (I)					0.3	0.3	0.3	0.3	21.5
Lembos sp. (Am)					0.7	0.7			21.5
Petricola pholadiformis (M)							0.7	0.7	21.5
Aeolidiidae A (M)	0.7	0.7							21.5
Odontosyllis fulgurans (P)	0.7	0.7							21.5
Brania clavata (P)	0.7	0.7							21.5
Hexapanopeus angustifrons (D)					0.3	0.3			32.0
Caprella equilibra (Am)					0.3	0.3			32.0
Turbellaria					0.3	0.3			32.0
Ophiothrix angulata (E)					0.3	0.3			32.0
Cumingia tellinoides (M)							0.3	0.3	32.0
Cerithiopsis sp. (M)							0.3	0.3	32.0
Sipunculida							0.3	0.3	32.0
Syllis gracilis (P)					0.3	0.3			32.0
Nereis falsa (P)	0.3	0.3							32.0
Podarke obscura (P)	0.3	0.3							32.0
Mediomastus californiensis (P)					0.3	0.3			32.0
Eulalia sanguinea (P)	0.3	0.3							32.0
Sabella microphthalma (P)					0.3	0.3			32.0

Appendix F.4 (Continued)

SPECIES	SUMMER, 1979 $\overline{x}$	SUMMER, 1979 SE	SUMMER, 1980 $\overline{x}$	SUMMER, 1980 SE	SUMMER, 1981 $\overline{x}$	SUMMER, 1981 SE	SUMMER, 1982 $\overline{x}$	SUMMER, 1982 SE	OVERALL RANK
NPO -2M LEVEL									
Erichthonius brasiliensis (Am)	28.0	13.1	6.7	4.3	22.0	4.7	2.3	0.9	1.0
Corophium sp. (Am)	16.7	8.5	6.7	4.3	1.3	1.3	33.0	20.4	2.0
Melita appendiculata (Am)					7.0	4.0	7.7	4.0	3.0
Lembos websteri (Am)	3.7	3.7			7.7	7.7	2.3	1.2	4.0
Astyris lunata (M)	1.0	0.0	8.3	3.8	4.0	2.1			5.0
Gammaropsis sp. (Am)			1.3	0.9	5.7	1.2	3.3	1.4	6.0
Amphiodia sp. (E)			0.7	0.7	2.0	1.5	5.3	3.0	7.0
Paracerceis caudata (I)	1.7	0.7	1.7	0.3	0.3	0.3	4.0	2.3	8.0
Lembos smithi (Am)					4.7	2.9	0.7	0.7	9.5
Caprella penantis (Am)	1.0	0.6	0.3	0.3	0.3	0.3	3.7	2.2	9.5
Elasmopus levis (Am)	0.3	0.3	1.7	1.2	2.3	1.8			11.0
Stenothoe sp. (Am)	1.0	1.0	0.3	0.3	1.0	0.0	1.3	0.9	12.0
Pista palmata (P)					3.3	2.4			13.0
Neopanope sayi (D)			0.3	0.3	2.7	0.9			14.0
Microdeutopus sp. (Am)	2.3	2.3							15.0
Jassa falcata (Am)							2.0	0.6	16.0
Erichsonella filiformis (I)							1.7	0.7	19.0
Lysianopsis alba (Am)					1.7	0.7			19.0
Jaeropsis coralicola (I)							1.7	0.3	19.0
Pelecypoda (M)			1.7	0.3					19.0
Podarke obscura (P)	0.7	0.7			0.7	0.7	0.3	0.3	19.0
Pinnotheres ostreum (D)	1.3	0.7							23.5
Xanthidae (D)			1.3	0.7					23.5
Nemertinea			0.7	0.7	0.3	0.3	0.3	0.3	23.5
Urosalpinx cinerea (M)			0.7	0.3	0.7	0.3			23.5
Caprella equilibra (Am)			0.7	0.7	0.3	0.3			28.5
Turbellaria					0.7	0.7	0.3	0.3	28.5
Musculus lateralis (M)					1.0	1.0			28.5
Nereis falsa (P)					1.0	0.6			28.5
Brania clavata (P)	1.0	0.6							28.5
Eulalia sanguinea (P)	1.0	0.6							28.5
Menippe mercenaria (D)			0.7	0.7					38.0
Microphrys bicornutus (D)			0.7	0.7					38.0
Ampelisca vadorum (Am)			0.3	0.3	0.3	0.3			38.0
Photis sp. (Am)					0.3	0.3	0.3	0.3	38.0
Leucothoe spinicarpa (Am)			0.3	0.3			0.3	0.3	38.0
Ophiothrix angulata (E)							0.7	0.3	38.0
Boonea seminuda (M)	0.7	0.3							38.0
Costoanachis lafresnayi (M)					0.3	0.3	0.3	0.3	38.0
Odostomia laevigata (M)	0.7	0.7							38.0

Appendix F.4 (Continued)

SPECIES	SUMMER, 1979		SUMMER, 1980		SUMMER, 1981		SUMMER, 1982		OVERALL RANK
	$\overline{x}$	SE	$\overline{x}$	SE	$\overline{x}$	SE	$\overline{x}$	SE	
			NPO -2M LEVEL						
Loimia medusa (P)			0.3	0.3	0.3	0.3			38.0
Arabella mutans (P)			0.7	0.3					38.0
Nereis succinea (P)			0.7	0.3					38.0
Mediomastus californiensis (P)			0.7	0.7					38.0
Latreutes parvulus (D)	0.3	0.3							55.5
Pilumnus sp. (D)					0.3	0.3			55.5
Pelia mutica (D)			0.3	0.3					55.5
Lembos unicornis (Am)			0.3	0.3					55.5
Paracaprella tenuis (Am)			0.3	0.3					55.5
Caprellidae (Am)	0.3	0.3							55.5
Pycnogonida							0.3	0.3	55.5
Anoplodactylus petiolatus (Py)					0.3	0.3			55.5
Caecum pulchellum (M)	0.3	0.3							55.5
Chione grus (M)							0.3	0.3	55.5
Chione sp. (M)			0.3	0.3					55.5
Pelecypoda B (M)	0.3	0.3							55.5
Hyboscolex longiseta (P)					0.3	0.3			55.5
Phyllodoce fragilis (P)							0.3	0.3	55.5
Lumbrineris coccinea (P)					0.3	0.3			55.5
Lepidonotus sublevis (P)	0.3	0.3							55.5
Odontosyllis fulgurans (P)	0.3	0.3							55.5
Nereidae (P)	0.3	0.3							55.5
Schistomeringos rudolphi (P)							0.3	0.3	55.5
Sabella microphthalma (P)					0.3	0.3			55.5
Prionospio cirrifera (P)	0.3	0.3							55.5
Syllis hyalina (P)							0.3	0.3	55.5

APPENDIX G: RANKED ABUNDANCE OF MOTILE MACROINVERTEBRATES COLLECTED BY SLURP GUN-SOUTH JETTY STATIONS

Appendix G.1 Ranked abundance of motile macroinvertebrates collected by slurp gun from station SEI. Estimates represent mean number per 65 cm^2 with standard error indicated and AM = Amphipod, D = Decapod, E = Echinoderm, I = Isopod, M = Mollusk, My = Mysid, P = Polychaete, Py = Pycnogonid.

SPECIES	SPRING, 1980		SUMMER, 1980		FALL, 1980		WINTER, 1981		SUMMER, 1981		SUMMER, 1982		OVERALL RANK
	$\overline{x}$	SE	$\overline{x}$	SE	$\overline{x}$	SE	$\overline{x}$	SE	$\overline{x}$	SE	$\overline{x}$	SE	
SEI +1M LEVEL													
Paradella quadripunctata (I)	0.3	0.3	3.3	1.8	11.7	1.8	N	N	N	N	N	N	1.0
Lembos unicornis (Am)					0.3	0.3	O	O	O	O	O	O	3.5
Paracaprella tenuis (Am)	0.3	0.3					B	B	D	D	D	D	3.5
Nemertinea			0.3	0.3			I	I	A	A	A	A	3.5
Nereis succinea (P)					0.3	0.3	O	O	T	T	T	T	3.5
							T	T	A	A	A	A	
							A	A					
SEI MLW													
Paradella quadripunctata (I)					4.0	1.5	9.3	3.8	N	N	N	N	1.0
Nereis succinea (P)					2.0	0.6	2.3	1.8	O	O	O	O	2.0
Lembos unicornis (Am)	0.3	0.3			1.3	1.3	0.3	0.3					3.5
Corophium sp. (Am)	1.7	1.2	0.3	0.3									3.5
Jassa falcata (Am)	0.7	0.3			0.3	0.3	0.3	0.3	D	D	D	D	5.5
Astyris lunata (M)	1.0	1.0					0.3	0.3	A	A	A	A	5.5
Elasmopus levis (Am)							1.0	1.0	T	T	T	T	8.5
Erichthonius brasiliensis (Am)					0.3	0.3	0.7	0.3	A	A	A	A	8.5
Caprella penantis (Am)	0.3	0.3					0.7	0.3					8.5
Podarke obscura (P)					1.0	0.6							8.5
Caprella equilibra (Am)	0.7	0.7											11.5
Terebellidae (P)					0.3	0.3	0.3	0.3					11.5
Pinnotheres maculatus (D)			0.3	0.3									14.5
Exosphaeroma diminutum (I)					0.3	0.3							14.5
Brania clavata (P)			0.3	0.3									14.5
Eulalia sanguinea (P)							0.3	0.3					14.5

Appendix G.2 Ranked abundance of motile macroinvertebrates collected by slurp gun from station SEO. Estimates represent mean number per 65 cm^2 with standard error indicated and AM = Amphipod, D = Decapod, E = Echinoderm, I = Isopod, M = Mollusk, My = Mysid, P = Polychaete, Py = Pycnogonid.

SPECIES	SPRING, 1980		SUMMER, 1980		FALL, 1980		WINTER, 1981		SUMMER, 1981		SUMMER, 1982		OVERALL RANK
	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	
							SEO +1M LEVEL						
Paradella quadripunctata (I)	0.3	0.3	0.7	0.3	0.7	0.3			6.0	2.6	28.7	7.8	1.0
Nemertinea					0.3	0.3			1.0	0.6	2.0	1.0	2.0
Jassa falcata (Am)					2.0	1.1	0.3	0.3					3.0
Caprella penantis (Am)	0.3	0.3			1.0	1.0							4.0
Caprella equilibra (Am)	0.7	0.3											5.5
Astyris lunata (M)					0.3	0.3							5.5
Microprotopus raneyi (Am)	0.3	0.3							0.3	0.3			8.0
Cerapus tubularis (Am)					0.3	0.3							8.0
Costoanachis lafresnayi (M)									0.3	0.3			8.0
							SEO MLW						
Caprella penantis (Am)	6.0	2.3	1.3	1.3	8.3	4.2	6.3	3.9	1.7	1.2			1.0
Jassa falcata (Am)	0.7	0.3			3.0	2.0	4.3	1.8	0.7	0.7			2.0
Corophium sp. (Am)	8.0	5.1											3.0
Paradella quadripunctata (I)			1.0	0.6	0.3	0.3	2.3	1.2	3.3	1.4	0.3	0.3	4.0
Microprotopus raneyi (Am)	4.7	2.7											5.0
Elasmopus levis (Am)					2.7	1.2	0.3	0.3	0.3	0.3			6.0
Erichthonius brasiliensis (Am)	2.7	2.7											7.0
Astyris lunata (M)			0.3	0.3	2.0	1.0							8.0
Mediomastus californiensis (P)					1.3	1.3							9.0
Caprella equilibra (Am)	1.0	0.6											11.0
Ampithoe valida (Am)									1.0	0.6			11.0
Nereis succinea (P)			0.3	0.3	0.7	0.7							11.0
Nanoplax xanthiformis (D)			0.7	0.7									15.5
Paracerceis caudata (I)					0.7	0.3							15.5
Microprotopus shoemakeri (Am)	0.7	0.7											15.5
Nemertinea											0.7	0.7	15.5
Phyllodoce castanea (P)			0.7	0.7									15.5
Podarke obscura (P)							0.3	0.3	0.3	0.3			15.5
Neopanope sayi (D)					0.3	0.3							25.0
Pinnotheres ostreum (D)									0.3	0.3			25.0
Majidae (D)			0.3	0.3									25.0
Ampithoe longimana (Am)					0.3	0.3							25.0
Erichsonella filiformis (I)									0.3	0.3			25.0
Cerapus tubularis (Am)									0.3	0.3			25.0
Lembos websteri (Am)	0.3	0.3											25.0
Sphaeroma quadridentatum (I)									0.3	0.3			25.0
Exosphaeroma diminutum (I)									0.3	0.3			25.0
Holothuroidea (E)					0.3	0.3							25.0
Petricola pholadiformis (M)									0.3	0.3			25.0
Arabella iricolor (P)					0.3	0.3							25.0
Polynoidae (P)	0.3	0.3											25.0

Appendix G.3 Ranked abundance of motile invertebrates collected by slurp gun from station SPI. Estimates represent mean number per 65 cm^2 with standard error indicated and Am = Amphipod, D = Decapod, E = Echinoderm, I = Isopod, M = Mollusk, My = Mysid, P = Polychaete, Py = Pycnogonid.

SPECIES	SPRING, 1980		SUMMER, 1980		FALL, 1980		WINTER, 1981		SUMMER, 1981		SUMMER, 1982		OVERALL RANK
	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	
SPI +1M LEVEL													
Paradella quadripunctata (I)			0.3	0.3	22.3	3.5	N	N	0.7	0.3	N	N	1.0
Isopoda A			4.0	1.5			O	O			O	O	2.0
Nereis succinea (P)					0.7	0.3							3.0
Paracaprella tenuis (Am)	0.3	0.3					B	B			D	D	6.0
Corophium sp. (Am)			0.3	0.3			I	I			A	A	6.0
Stenothoe sp. (Am)	0.3	0.3					O	O			T	T	6.0
Caprella penantis (Am)			0.3	0.3			T	T			A	A	6.0
Jassa falcata (Am)	0.3	0.3					A	A					6.0
SPI MLW													
Paradella quadripunctata (I)			0.7	0.3	3.0	1.1							1.0
Corophium sp. (Am)	2.0	2.0	0.3	0.3									2.0
Brania clavata (P)							1.3	0.3	N	N	N	N	3.0
Gammarus mucronatus (Am)							1.0	0.6					4.5
Caprella equilibra (Am)	1.0	0.6							O	O	O	O	4.5
Colomastix sp. (Am)							0.7	0.7					7.0
Caprella penantis (Am)	0.3	0.3	0.3	0.3									7.0
Astyris lunata (M)							0.7	0.3	D	D	D	D	7.0
Paracaprella tenuis (Am)							0.3	0.3					11.5
Gammaridae (Am)					0.3	0.3			A	A	A	A	11.5
Jassa falcata (Am)	0.3	0.3											11.5
Endeis spinosa (Py)	0.3	0.3							T	T	T	T	11.5
Nemertinea							0.3	0.3					11.5
Mediomastus californiensis (P)							0.3	0.3	A	A	A	A	11.5
SPI -1M LEVEL													
Caprella equilibra (Am)	61.7	47.0					0.7	0.7	N	N	N	N	1.0
Astyris lunata (M)	1.3	0.9	4.7	1.2	13.3	3.7	24.0	3.0	O	O	O	O	2.0
Corophium sp. (Am)	39.7	37.2					0.7	0.3					3.0
Jassa falcata (Am)	23.0	17.3					1.0		D	D	D	D	4.0
Paracaprella tenuis (Am)	8.7	5.9			1.3	0.7	1.0	0.6	A	A	A	A	5.0
Erichthonius brasiliensis (Am)	1.3	0.7	0.3	0.3	3.3	2.4	5.0	1.7	T	T	T	T	6.0
Melita appendiculata (Am)	3.3	3.3	0.3	0.3	3.3	0.3	1.0	0.6	A	A	A	A	7.0
Caprella penantis (Am)	6.3	3.2											8.0
Lembos unicornis (Am)					2.7	1.2	2.3	1.2					9.0
Elasmopus levis (Am)					2.0	1.5	1.0	1.0					10.0

Appendix G.3 (Continued)

SPECIES	SPRING, 1980 $\bar{x}$	SPRING, 1980 SE	SUMMER, 1980 $\bar{x}$	SUMMER, 1980 SE	FALL, 1980 $\bar{x}$	FALL, 1980 SE	WINTER, 1981 $\bar{x}$	WINTER, 1981 SE	SUMMER, 1981 $\bar{x}$	SUMMER, 1981 SE	SUMMER, 1982 $\bar{x}$	SUMMER, 1982 SE	OVERALL RANK
SPI - 1M LEVEL													
Cerithiopsis fusiforme (M)			2.7	1.2									11.0
Xanthidae (D)			2.3	0.3									12.0
Leucothoe spinicarpa (Am)					0.7	0.3	1.3	0.9					13.5
Stenothoe sp. (Am)	0.7	0.3			0.3	0.3	1.0		N	N	N	N	13.5
Lemos smithi (Am)							1.7	1.2					15.0
Neopanope sayi (D)					1.0	0.6			O	O	O	O	20.0
Gammarus mucronatus (Am)							1.0	0.6					20.0
Stenothoe sp. B (Am)	1.0	0.6											20.0
Paradella quadripunctata (I)			0.7	0.7	0.3	0.3							20.0
Tanystylum orbiculare (Py)	1.0	1.0							D	D	D	D	20.0
Urosalpinx cinerea (M)							1.0	0.6					20.0
Armandia maculata (P)					0.3	0.3	0.7	0.3	A	A	A	A	20.0
Brania clavata (P)					0.7	0.7	0.3	0.3					20.0
Polydora caeca (P)					0.7	0.7	0.3	0.3	T	T	T	T	20.0
Libinia dubia (D)					0.7	0.7							26.5
Lembos websteri (Am)	0.7	0.7							A	A	A	A	26.5
Paracerceis caudata (I)					0.7	0.3							26.5
Nudibranchia (M)	0.3	0.3			0.3	0.3							26.5
Periclimenes longicaudatus (D)							0.3	0.3					36.0
Latreutes parvulus (D)			0.3	0.3									36.0
Luconacia incerta (Am)					0.3	0.3							36.0
Gammaropsis sp. (Am)	0.3	0.3											36.0
Heteromysis formosa (My)	0.3	0.3											36.0
Colomastix sp. (Am)							0.3	0.3					36.0
Nymphonidae (Py)	0.3	0.3											36.0
Ophiothrix angulata (E)							0.3	0.3					36.0
Calliostoma sp. (M)							0.3	0.3					36.0
Pelecypoda (M)							0.3	0.3					36.0
Gastropoda (M)	0.3	0.3											36.0
Costoanachis lafresnayi (M)							0.3	0.3					36.0
Loimia medusa (P)	0.3	0.3											36.0
Sabellidae (P)							0.3	0.3					36.0
Eulalia sanguinea (P)							0.3	0.3					36.0

Appendix G.4 Ranked abundance of motile macroinvertebrates collected by slurp gun from station SPO. Estimates represent mean number per 65 m^2 with standard error indicated and Am = Amphipod, D = Decapod, E = Echinoderm, I = Isopod, M = Mollusk, My = Mysid, P = Polychaete, Py = Pycnogonid.

SPECIES	SPRING, 1980		SUMMER, 1980		FALL, 1980		WINTER, 1981		SUMMER, 1981		SUMMER, 1982		OVERALL RANK
	$\overline{x}$	SE	$\overline{x}$	SE	$\overline{x}$	SE	$\overline{x}$	SE	$\overline{x}$	SE	$\overline{x}$	SE	
SPO +1M LEVEL													
Paradella quadripunctata (I)			6.7	1.2	15.0	1.7			7.7	1.7	3.7	2.7	1.0
Sphaeroma quadridentatum (I)									0.7	0.7	2.3	1.2	2.0
Nemertinea			1.0	1.0									3.0
Caprella penantis (Am)			0.7	0.3									4.0
Photis sp. (Am)							0.3	0.3					6.5
Corophium sp. (Am)			0.3	0.3									6.5
Astyris lunata (M)	0.3	0.3											6.5
Phyllodoce castanea (P)									0.3	0.3			6.5
SPO MLW													
Caprella penantis (Am)	72.7	38.9	44.3	17.4	3.7	1.4	0.3	0.3			19.0	7.2	1.0
Jassa falcata (Am)	28.0	9.0	1.0	0.6	5.0		3.7	2.2	0.7	0.3	3.3	1.3	2.0
Corophium sp. (Am)	1.7	1.2	2.0	0.6							9.0	1.5	3.0
Paradella quadripunctata (I)			1.3	0.9	2.7	1.2	1.7	0.7			6.3	2.6	4.0
Elasmopus levis (Am)					6.7	2.7			0.7	0.3			5.0
Caprella equilibra (Am)	3.7	1.8			1.0	0.6							6.0
Stenothoe sp. (Am)	0.3	0.3			1.7	1.7			0.7	0.3			7.0
Astyris lunata (M)			0.3	0.3	1.3	1.3			0.3	0.3			8.0
Erichthonius brasiliensis (Am)	0.7	0.3	0.3	0.3	0.3	0.3					0.3	0.3	9.0
Erichsonella filiformis (I)			0.3	0.3	0.3	0.3					0.3	0.3	10.5
Exosphaeroma diminutum (I)			1.0	1.0									10.5
Paracerceis caudata (I)			0.7	0.7									13.0
Ampithoe valida (Am)									0.3	0.3	0.3	0.3	13.0
Nudibranchia (M)	0.7	0.3											13.0
Neopanope sayi (D)									0.3	0.3			18.0
Pinnotheres ostreum (D)									0.3	0.3			18.0
Paracaprella tenuis (Am)											0.3	0.3	18.0
Elasmopus sp. (Am)									0.3	0.3			18.0
Petricola pholadiformis (M)			0.3	0.3									18.0
Cistenides gouldii (P)							0.3	0.3					18.0
Brania clavata (P)									0.3	0.3			18.0

Appendix G.4 (Continued)

SPECIES	SPRING, 1980		SUMMER, 1980		FALL, 1980		WINTER, 1981		SUMMER, 1981		SUMMER, 1982		OVERALL RANK
	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	
SPO -1M LEVEL													
Jassa falcata (Am)	38.0	10.6	0.3	0.3	1.0		62.0	9.5	0.5	0.5			1.0
Caprella penantis (Am)	43.4	9.3	3.3	1.8	1.3	0.3	13.3	3.4	0.5	0.5			2.0
Caprella equilibra (Am)	11.7	2.2			15.0	7.6	17.0	7.5			N	N	3.0
Corophium sp. (Am)	21.3	4.8	12.3	9.9			0.3	0.3	1.0	1.0			4.0
Stenothoe sp. (Am)	0.3	0.3			2.7	2.7	25.3	4.3			O	O	5.0
Elasmopus levis (Am)			0.3	0.3	1.0	0.6	13.0	3.6	1.5	0.5			6.0
Erichthonius brasiliensis (Am)			1.7	1.2	8.3	0.3	1.3	0.9					7.0
Astyris lunata (M)			1.7	1.7	1.7	0.7	3.3	1.2	1.5	0.5	D	D	8.0
Paradella quadripunctata (I)							7.0	5.5					9.0
Pelecypoda (M)					0.3	0.3	2.3	1.3			A	A	10.0
Lembos unicornis (Am)					0.3	0.3	1.3	0.7					11.5
Petricola pholadiformis (M)			0.7	0.7					1.5	1.5	T	T	11.5
Paracaprella tenuis (Am)	0.3	0.3					0.7	0.3					14.5
Paracerceis caudata (I)			0.3	0.3					1.0	1.0	A	A	14.5
Nematoda			1.0	1.0									14.5
Nudibranchia (M)							1.0	0.6					14.5
Neopanope sayi (D)			0.3	0.3					0.5	0.5			19.0
Nanoplax xanthiformis (D)			0.3	0.3	0.3	0.3							19.0
Melita appendiculata (Am)							0.7	0.3					19.0
Anoplodactylus petiolatus (Py)					0.7	0.7							19.0
Musculus lateralis (M)									1.0	1.0			19.0
Erichsonella filiformis (I)			0.3	0.3									24.0
Photis sp. (Am)							0.3	0.3					24.0
Microprotopus shoemakeri (Am)	0.3	0.3											24.0
Nereis falsa (P)									0.5	0.5			24.0
Nereis succinea (P)							0.3	0.3					24.0

APPENDIX H: ESTIMATES OF SPECIES NUMBER, ABUNDANCE, AND DIVERSITY OF MOTILE EPIFAUNA COLLECTED IN SUCTION SAMPLES-NORTH AND SOUTH JETTY STATIONS

Appendix H.1 Estimates of species number, abundance, and diversity of motile epifauna collected in suction samples at north jetty stations.

	SU79	SU80	SU81	SU82		SU79	SU80	SU81	SU82	
NPO +1m	4	1	3	2	NEO +1m	4	2	7	4	# spp
	45	5	8	5		15	7	11	36	# ind
	0.46	0.00	1.06	0.97		1.04	0.59	2.55	1.48	H'
	0.23	-	0.67	0.97		0.52	0.59	0.91	0.74	J'
	0.79	0.00	0.96	0.62		1.11	0.51	2.50	0.84	SR
NPO MLW	5	6	14	12	NEO MLW	7	6	14	2	# spp
	78	11	39	90		78	22	100	32	# ind
	0.79	2.22	2.89	2.42		1.55	2.08	2.31	0.34	H'
	0.34	0.86	0.76	0.68		0.55	0.81	0.61	0.34	J'
	0.92	2.09	3.55	2.44		1.38	1.62	2.82	0.29	SR
NPO -1m	14	8	24	16	NEO -1m	15	12	20	21	# spp
	73	24	199	110		65	96	138	74	# ind
	3.07	2.16	3.41	2.05		2.64	3.45	3.27	3.73	H'
	0.81	0.72	0.74	0.51		0.68	0.96	0.76	0.85	J'
	3.03	2.20	4.35	3.19		3.35	2.41	3.86	4.65	SR
NPO -2m	23	27	31	25	NEO -2m	14	16	23	27	# spp
	191	116	221	220		53	71	106	108	# ind
	2.73	3.77	3.75	3.11		3.40	3.13	3.85	3.87	H'
	0.60	0.79	0.76	0.67		0.89	0.78	0.85	0.81	J'
	4.19	5.47	5.56	4.45		3.27	3.52	4.72	5.55	SR
NPI +1m	3	1	2	1	NEI +1m	1	1	5	4	# spp
	152	3	3	1		32	4	45	47	# ind
	0.35	0.00	0.92	0.00		0.00	0.00	1.47	1.17	H'
	0.22	-	0.92	-		-	-	0.63	0.59	J'
	0.40	0.00	0.91	-		0.00	0.00	1.05	0.78	SR
NPI MLW	12	10	11	1	NEI MLW	12	7	8	22	# spp
	59	19	23	1		82	30	48	152	# ind
	2.94	2.97	3.01	0.00		2.73	2.25	1.52	3.04	H'
	0.82	0.89	0.87	-		0.76	0.80	0.51	0.68	J'
	2.70	3.06	3.19	-		2.50	1.76	1.81	4.18	SR
NPI -1m	24	28	28	30	NEI -1m	18	23	33	27	# spp
	127	136	202	109		58	80	117	92	# ind
	3.42	4.26	3.48	3.71		3.48	3.42	4.12	4.08	H'
	0.75	0.89	0.72	0.76		0.84	0.76	0.82	0.86	J'
	4.75	5.50	5.09	6.18		4.19	5.02	6.72	5.75	SR

Appendix H.2 Estimates of species number, abundance, and diversity of motile epifauna collected in suction samples at south jetty stations.

	SP80	SU80	FA80	WI81	SU81	SU82	
SPO +1m	1	4	1	1	3	2	# spp
	1	26	45	1	26	18	# ind
	0.00	1.12	0.00	0.00	0.62	0.96	H'
	-	0.56	-	-	0.39	0.96	J'
	-	0.92	0.00	-	0.61	0.35	SR
SPO MLW	7	10	9	4	9	8	# spp
	323	155	68	18	12	117	# ind
	1.26	1.00	2.68	1.41	3.08	1.96	H'
	0.45	0.30	0.85	0.71	0.97	0.65	J'
	1.04	1.78	1.90	1.04	3.22	1.47	SR
SPO -1m	7	12	11	16	10*		# spp
	346	68	98	448	19*	NO DATA	# ind
	1.92	2.32	2.35	2.66	3.18*		H'
	0.68	0.65	0.68	0.67	0.96*		J'
	1.03	2.61	2.18	2.46	3.06*		SR
SPI +1m	3	4	2	0	1		# spp
	3	15	69	0	2		# ind
	1.58	1.04	0.19	-	0	NO DATA	H'
	1.00	0.52	0.19	-	-		J'
	1.82	1.11	0.24	-	0		SR
SPI MLW	5	3	2	7			# spp
	12	4	10	14			# ind
	1.90	1.50	0.47	2.61	NO DATA	NO DATA	H'
	0.82	0.95	0.47	0.93			J'
	1.61	1.44	0.43	2.27			SR
SPI -1m	18	7	17	25			# spp
	452	34	96	140			# ind
	2.40	2.18	3.03	2.98	NO DATA	NO DATA	H'
	0.58	0.78	0.74	0.64			J'
	2.78	1.70	3.51	4.86			SR
SEO +1m	4	1	6	1	4	2	# spp
	5	2	14	1	23	92	# ind
	1.92	0.00	2.22	0.00	1.05	0.35	H'
	0.96	-	0.86	-	0.53	0.35	J'
	1.86	0.00	1.89	-	0.96	0.22	SR
SEO MLW	9	7	12	5	12	2	# spp
	73	14	61	41	28	3	# ind
	2.48	2.61	2.72	1.74	2.97	0.92	H'
	0.78	0.93	0.76	0.75	0.83	0.92	J'
	1.86	2.27	2.68	1.08	3.30	0.91	SR

Appendix H.2 (Continued)

	SP80	SU80	FA80	WI81	SU81	SU82	
SEI +1m	2	2	3	0			# spp
	2	11	37	0			# ind
	1.00	0.44	0.36	-	NO	NO	H'
	1.00	0.44	0.23	-	DATA	DATA	J'
	1.44	0.42	0.55	-			SR
SEI MLW	6	3	8	10			# spp
	14	3	29	47			# ind
	2.35	1.58	2.40	2.09	NO	NO	H'
	0.91	1.00	0.80	0.63	DATA	DATA	J'
	1.89	1.82	2.08	2.34			SR

* values based on two replicates only